LECTURE NOTES

ON

AIRPORT OPERATIONS

B.Tech VII Semester

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UNIT - I
THE AIRPORT AS AN OPERATIONAL SYSTEM

The airport forms an essential part of the air transport system because it is the physical site at which a modal. Transfer is made from the air mode to the land mode or vice versa. It is the point of interaction of the three major components of the air transport system. The airport, including its commercial & operational concessionaires, tenants, and partners, plus. These discussion purposes, the airways control system.

- The airline
- The user

The interaction among these three major components must be made to have successful rate and planning and operation is also must. To operate well, each should reach some form of equilibrium with the other two.

In the absence of a competitive option, total demand levels will be depressed below levels achievable in the optimal state. Sub-optimality can become manifest in a number of ways.

Deficit operations at the airport

Deficit operations by the airlines at the airport Unsatisfactory working conditions for airline airport employs.

In adequate passenger accommodation

In sufficient flight supply, unsafe operations, High operational costs to useless, in adequate support facilities for airlines, High delay levels for airlines of passengers, inadequate access facilities, sluggish passengers demand.

1.1 Function of the airport:

An airport is either an intermediate or terminal point for an aircraft on the air portion of a trip.In simple functional terms the facility must be designed to enable an a/c to land & take off In b/w their two operations, the aircraft may, if required, unload and load payload & crew & be serviced Airport operations are divided into airside & land side functions. After approach and landing an aircraft uses the runway, taxiway and apron prior to docking at a Packing position, where its payload is processed through the terminal to the access system. The airport passenger and freight terminals are themselves facilities that have three distinct functions.

Change of mode: To provide linkage b/w the air vehicle of the surface vehicle designed to accommodate the operating characteristics of the vehicles on landside & airside respectively.

Processing: To provide the necessary facilities for ticketing, documentation and control of passengers and freight.

Change of movement type: To convert continual shipments of freight by trucks of departing passengers by car, bus, taxi & train to aircraft sized batches that generally depart according to a preplanned schedule or to reverse this process for arriving aircraft. Airports of a significant size must have an organization that can either supply or administer the following Faculties

The complexity of the Airport operation:

Until the deregulation & privatization of the air transport industry in the late 1970s & 1980s, it had been seen in many countries almost as a public service industry that required support from the Public purpose.

Airports such as Shannon in republic & Amsterdam in Netherlands were among the first to develop income from commercial activities. By 1970s commercial revenues had become very implores of total income. The larger airports became complex business with functions that extended well beyond the airfield or "traffic" side of operations. It is also clear that in most countries, airports maintain economic viability by developing a broadly based capability. As the relative and big sizes of the non-traffic element of the airports revenue increase, much more attention must be paid to developing commercial expertise, some of the largest airports have developed considerable in-house expertise in maximizing commercial revenues.

The non-aeronautical activities found at airports are (ICA0) 2006:
Aviation fuel suppliers
Food & beverage sales (i.e. restaurants, bars cafeterias etc)
Duty paid shopping
Banks / Foreign exchange
Airline catering services
Taxi services
Car rentals
Advertising
Airport /City transport services (i.e. buses, limousines etc.
Duty free shopping (e.g. alcohol, tobacco, perfume, watches, optical)
Petrol/automobile service stations
Hair dressing/barber shop
Internet services
Casinos/gaming machines
Cinema
Vending machines for other than food
Freight consolidators
Art concerts
Music concerts
Souvenir shops

The degree to which airports go to a non-aeronautical activity is likely to depend on the destination of the revenues generated from such activities. These go directly to the airport and add to the airports profitability. There are number of situations that can act as disincentive to the airport company. Where the income from non-aeronautical source go directly to the national treasury of the country. Where the government give the duty-free franchise to the government-owned airline. Where the U. S airport is operated on a residual cost basis and income from non-aero sources is used to reduce landing fear for the airlines 5 does not accrue to the airport.

1.2 Airport as an Operational system:

Private airports and public use airports.

Airport planning is a systematic process used to establish guidelines for the efficient development of airports that is consistent with local, state & national goals. Key object of airport planning is to assure the effective use of airport resources in order to satisfy aviation demand in a financially feasible manner.

1. National system planning.
2. State airport system planning
3. Metropolitan airport system planning
4. Airport Master planning

Limitations of use:
FAA policies are applicable such as USC, united state code, public law (PL), and code of federal regulations of official FAA policies.

Public & Private use airport

When we think of public airports, it is usually commercial service we think. However, Oregon's system of more than 100 public use airports includes a half dozen commercial service airports.
All public categories for purpose of oregano aviation plan.

Private air charter services, one advantage to use a private airport is the privacy factor. Travelling details are kept confidentially including the destination, members of travelling parity& Potential return dates.

1. **Commercial service airports**:
   There are publicly owned a/ps that have at least 2,500 passenger
   Boarding's each calendar year &receive schedule passenger service.
   Significant function is accommodate scheduled major/or national or regional/commercial air carrier service. And is designated criteria is scheduled commercial service.

2. **General Aviation airports**:
   Their significant function is accommodating corporate aviation activity, including business jets, helicopters and other general aviation activities. Their designated criteria are 30,000 or more annual operations, of which a minimum of 500 are business related aircraft. Business use heliports.

3. **Regional airports**:
   Accommodate a wide range of general aviation users for large service areas in outlying parts of Oregon. Many also accommodate seasonal regional fire response activities with large a/c.
   Designation criteria
   Generally less than 30,000 operations.
   Geographically significant location with multiple communities in the service area.
   Changes in airport categorization will be based on measured changes against the designation criteria. Airports may request review by department

   Generated traffic is traffic b/w hub airport H &airport, Although we tend to focus on the importance of transfer traffic at hubs, these are still highly dependent on non-transfer traffic, since some flight sectors have important shares of non-transfer passengers & increase of direct ervices at the hub can produce a multiplying affection the generation of traffic from off to the hub. As a matter of fact, most hubs are located in regions with large local markets.

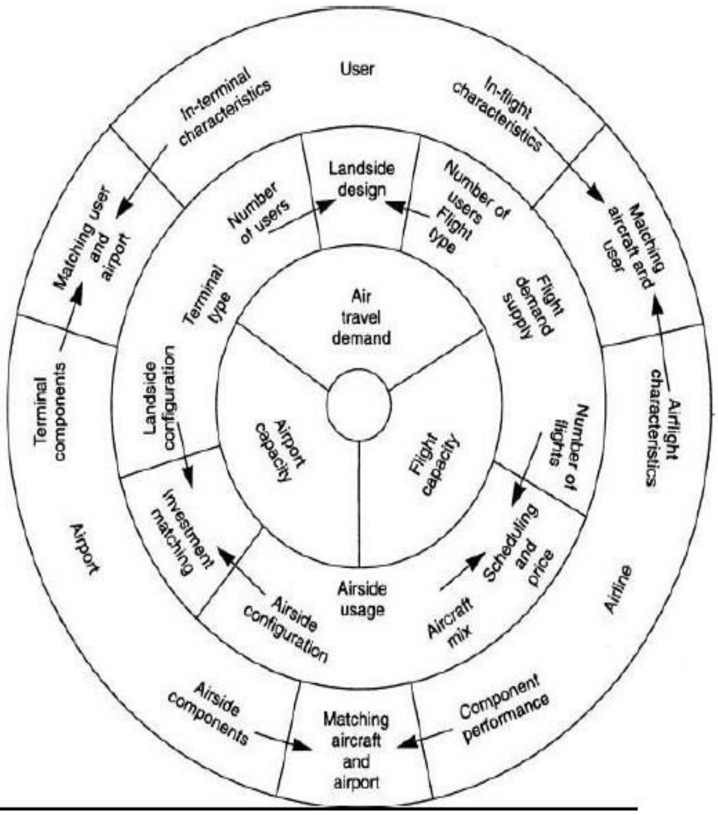

Fig.1.1 A hierarchical system of airport relationships

Airport by categories of airport activities, including commercial service, primary, cargo service, reliever and general aviation airports as shown below.

1.3 Categories of airport activities

<table>
<tr><th colspan="2">Air

Airport Classifications port Classifications</th><th>Hub Type: Percentage of Annual Passenger Boarding's</th><th>Common Name</th></tr>
<tr><td rowspan="3">Commercial Service: Publicly owned airports that have at least 2,500 passenger boarding's each calendar year and receive scheduled passenger service</td><td rowspan="3">Primary: Have more than 10,000 passenger boarding's each year §47102(16)</td><td>Large: 1% or more</td><td>Large Hub</td></tr>
<tr><td>Medium: At least 0.25%, but less than 1%</td><td>Medium Hub</td></tr>
<tr><td>Small:</td><td>Small Hub</td></tr>
</table>

§47102(7)		At least 0.05%, but less than 0.25%	
	Non primary	**Non hub:** More than 10,000, but less than 0.05%	**Non hub Primary**
		Nonhub: At least 2,500 and no more than than 10,000	**Nonprimary** **Commercial Service**
Nonprimary (Except Commercial Service)		Not Applicable	**Reliever** **§(47102(23))** **General Aviation** **(47102(8))**

Of aviation of their categorization of any time, so move L/W categories, the airport must meet designation criteria using 3 year average. Inventory gets updated for every 5 years & a system-wide review of categories will be conducted general aviation airports. Airports with fewer than 2,500 annual enplaned passengers used exclusively by private business a/c act providing commercial air carrier passenger's service.

1.4 Hub classification:

Hub and spoke operations are typically achieved by consolidating originating and transfer passenger flows, which imply the existence of two dimensions of "hubbing" traffic generation & connectivity. Connecting traffic is traffic b/w Airport A&B via the hub airport H. Effective hubbing then generates Substantial volume of additional traffic at the hub airport the city-pair coverage that can be obtained is Significant, since increase in the number of airports served from the hub impacts exponentially on the Number of city-pairs served.

Many small airports that provide little more than a simple passenger terminal for low-volume passenger Operations provide very little more than a passenger terminal facility. The operation of the airport is not significantly more complex than that of a railroad station or an interurban bus station, Medium-or large-Scale airports are very much more complex and require an organization that can cope with such Complexity, airports of a significant size must have an organization that can either supply or administer Handling of passengers Servicing, maintaining, and engineering of aircraft. Airline operations, including aircrew, cabin attendants, ground crew, and terminal and office Business that provide services to passengers and are necessary for the economic stability of the airport (e.g. concessionaries, leasing companies et) Aviation support facilities.

Organizational structure

A very different form of functional arrangement exists in U.S. airports, where the airport authority requires that all the operational aspects of passenger and freight handling are carried out by the airlines and handling companies. The organization of the Los Angeles World Airports organization shown in Figure 1.32 and those of Sacramento and San Francisco airports are shown in Figures 1.2 and 1.3.

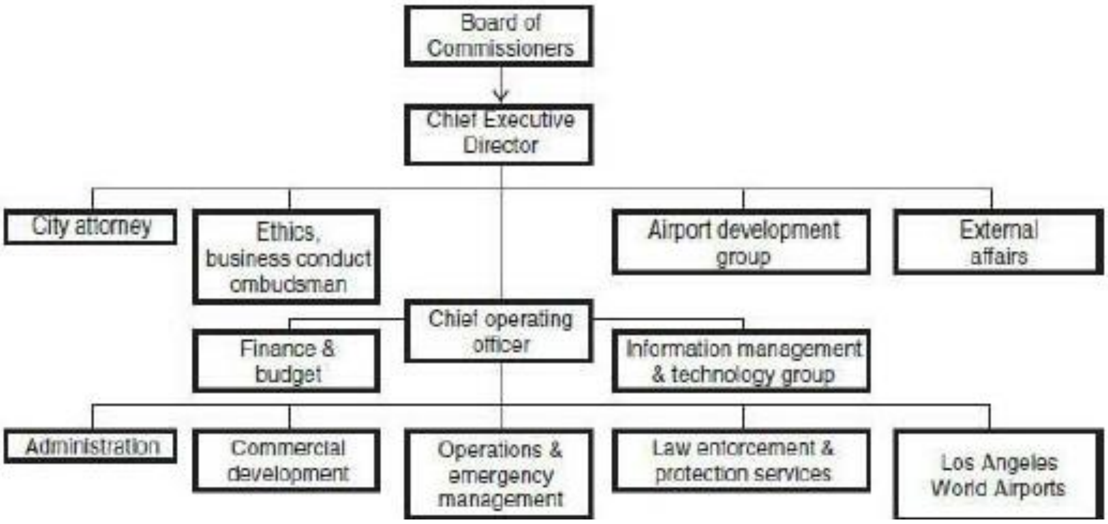

Fig.1.2. Organizational structure of Los Angeles

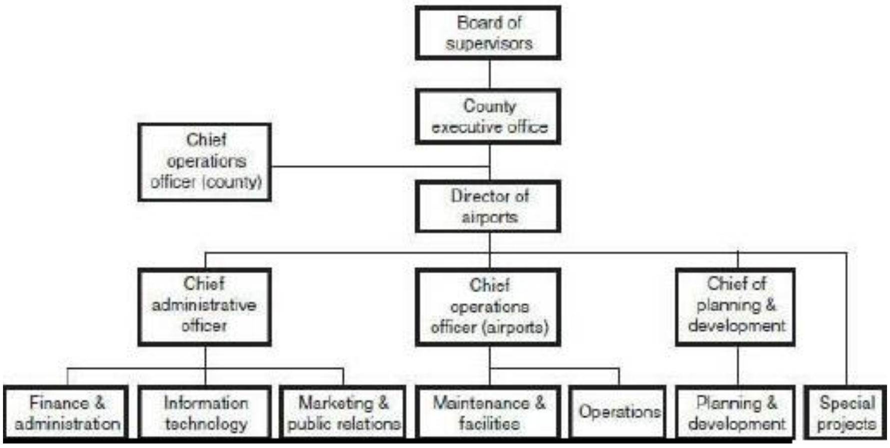

Fig.1.3.Organizational structure of Sacramento Airport

1.5 Components of Airport

Therefore, the **main components of airport are**

1. Landing Area of Airport

   It is the airport components used for landing and takeoff operations of an aircraft. Landing Area includes ***Runways*** and ***taxiways***.

2. Terminal Area

   The transition of passengers and goods from ground to air takes place in the terminal area. Various methods are used to accommodate and transfer the public and its goods arriving either by ground or by air. The degree of development in the terminal area depends upon volume of airport, operations, type of air traffic using airport, number of passengers and the airport employees to be served and the manner in which they are served and accommodated. Terminal area consists of the following parts *Terminal building*, *Apron*, *Automobile Parking Area*, *Hangers*.

Landing area is the component of airport used for landing and takeoff operations of an aircraft. Landing area includes

1. Runways
2. Taxiways

1. Runways

It is the most important part of an airport in the form of paved, long and narrow rectangular strip which actually used for landing and takeoff operations. It has turfed (grassy) shoulders on both sides. The width of runway and area of shoulders is called the landing strip. The runway is located in the center of landing strip. The length of landing strip is somewhat larger than the runway strip in order to accommodate the stop way to stop the aircraft in case of abandoned takeoff.

The length and width of runway should be sufficient to accommodate the aircraft which is likely to be served by it. The length of runway should be sufficient to accelerate the aircraft to the point of takeoff and should be enough such that the aircraft clearing the threshold of runway by 15m should be brought to stop with in the 60% of available runway length. The length of runway depends on various meteorological and topographical conditions. Transverse gradients should not be less than 0.5% but should always be greater than 0.5%.

2. Taxiways

Taxiway is the paved way rigid or flexible which connects runway with loading apron or service and maintenance hangers or with another runway. They are used for the movement of aircraft on the airfields for various purposes such as exit or landing, exit for takeoff etc. The speed of aircraft on taxiway is less than that during taking off or landing speed.

The taxiway should be laid on such a manner to provide the shortest possible path and to prevent the interference of landed aircraft taxying towards loading apron and the taxiing aircraft running towards the runway. The intersection of runway and taxiway should be given proper attention because during turning operation, this part comes under intense loading. If it is weaker than the aero plane may fell down from taxiway. Its longitudinal grade should not be greater than 3% while its transverse gradient should not be less than 0.5%. It is also provided with a shoulder of 7.5m width paved with bituminous surfacing. The taxiway should be visible from a distance of 300m to a pilot at 3m height from the ground.

1.6 Centralized and Decentralized Passenger Terminal Systems

The way in which an airport terminal system is operated and the administrative structure of the operating company may be affected by the physical design of the airport itself. It is convenient to classify airports into two broad and very different operational types: centralized and decentralized. Most older terminals were designed using the centralized concept, where processing was carried out in the main terminal building, and access to the aircraft gates was attained by piers and satellites or by apron transport. Many airports still operate quite satisfactorily using centralized facilities (e.g., Tampa and Amsterdam Schiphol).

Other airports started life as centralized facilities but became decentralized when additional terminals were added to cope with increased traffic (e.g., London Heathrow, Paris Orly, and Madrid Barajas).

Some airports were designed to initio as decentralized facilities operating with a number of unit terminals, each with a complete set of facilities (e.g., Dallas–Fort Worth, Paris Charles de Gaulle, Kansas City, and New York JFK).

A hybrid form of centralization/decentralization occurs with extensive remote pier developments (e.g., Atlanta and Hong Kong) and remote satellites (e.g., Pittsburgh and Kuala Lumpur). Figure 1.4 shows examples of centralized and decentralized layouts, respectively.

1.7 Privatization of Airport

With the privatization of many of the larger airports since 1987, a number of private companies now own airports on a multinational basis. The structure of these organizations become very complex, as can be seen from the example shown in Figure 1.5. This indicates the structure of an organization involved in the ownership, management, or operation of some 30 airports in North and South America and Europe in 2011.

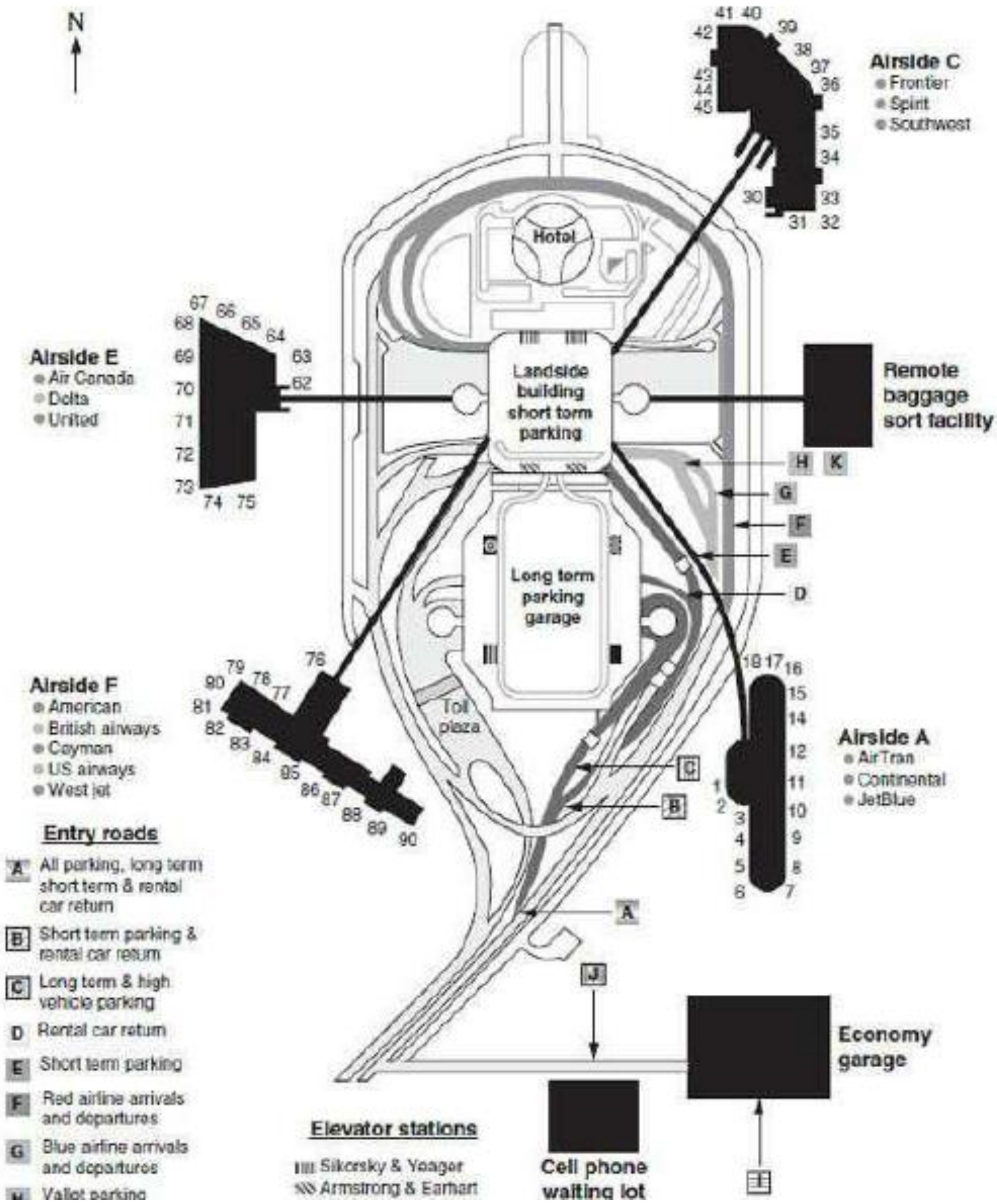

Fig.1.4. Schematic of Tampa International Airport—a centralized terminal layout

Source from Norman J. Ashford, The McGraw Hill, 3rd Edition, 2013.

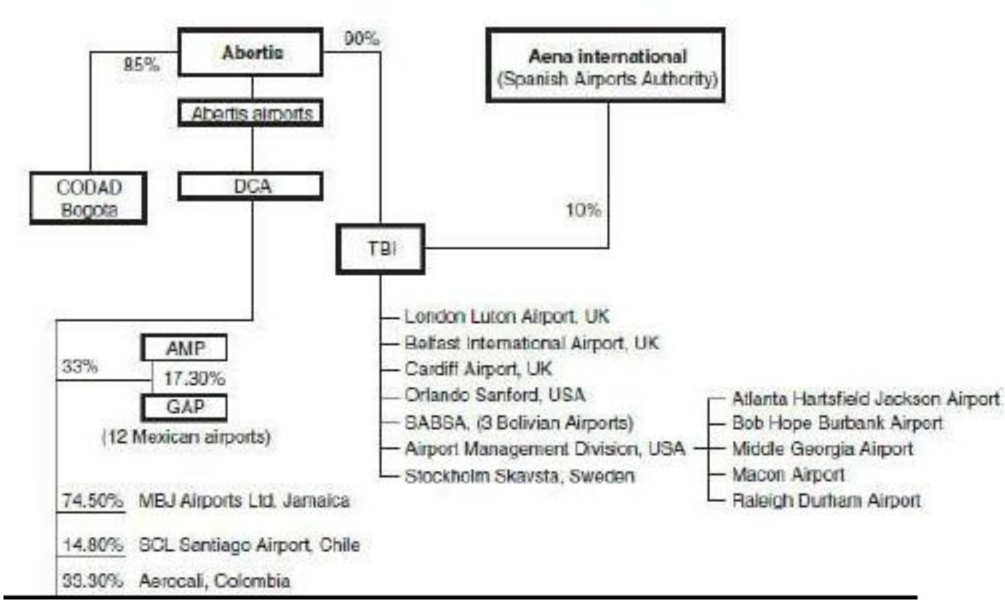

Fig.1.5. The structure of a private company having multinational airport interests

1.8 The National Plan of Integrated Airport Systems

The Federal Aviation Administration has recognized a subset of the 5,400 public-use airports in the United States as being vital to serving the public needs for air transportation, either directly or indirectly, and may be made eligible for federal funding to maintain their facilities. The **National Airport System Plan (NASP)** was the first such plan, which recognized approximately 3,200 such airports. In addition, the NASP categorized these airports on the basis of each airport's number of annual enplanements and the type of service provided.

The NASP categorized airports as being "commercial service airports" if the airport enplaned at least 2,500 passengers annually on commercial air carriers or charter aircraft. Commercial service airports were subcategorized as "air carrier" airports and "commuter" airports, depending on the type of service dominant at a given airport. Airports that enplaned less than 2,500 passengers annually were classified as "general aviation airports."In 1983, the final year of the NASP, a total of 780 commercial service airports (635 air carrier airports and 145 commuter airports) and 2,423 general aviation airports were recognized under the NASP.

With the passage of the Airport and Airway Act of 1982, the FAA was charged with preparing a new version of the NASP, to be called the **National Plan of Integrated Airport Systems (NPIAS).** The NPIAS revised the method of classifying airports, primarily to reflect the extreme growth in annual enplanements that a relative few of the largest airports were experiencing at the time. As of 2002, a total of 3,364 airports in the United States were included in the NPIAS.
The categories of airports listed in the NPIAS are:

1. Primary commercial service airports
2. Commercial service airports
3. General aviation airports
4. Reliever airports

Commercial service airports

Commercial service airports are those airports that accommodate scheduled air carrier service, provided by the world's certificated air carriers. Virtually all of the 650 million passengers that boarded commercial aircraft in 2001 began, transferred through, and ended their trips at commercial service airports.

Commercial service airports operate under very specific regulations enforced by the Federal Aviation Administration, Transportation Security Administration, as well as state and local governments. In addition, other federal and local administrations, such as the Environmental Protection Agency, and local economic development organizations, indirectly affect how commercial service airports operate. The goal of commercial service airports, of course, is to provide for the safe and efficient movement of passengers and cargo between population centers through the nation's aviation system. In 2002, there were a total of 546 commercial service airports throughout the United States striving to fulfill this mission.

Primary commercial service airports

Primary commercial service airports are categorized in the NPIAS as those public-use airports enplaning at least 10,000 passengers annually in the United States. In 2002, there were 422 airports (less than 3 percent of the nation's total airports) categorized as primary commercial service airports. Within this exclusive group of airports, the range of airport size and activity level is very wide, and the distribution of passenger enplanements is highly skewed. About half the primary commercial service airports handle relatively little traffic; the vast majority of passengers are enplaned through relatively few very large airports. This phenomenon is a direct result of the airline routing strategy, known as the "hub and spoke" system that was adopted by several of the nation's largest carriers. In fact, the top five airports in the United States, in terms of annual enplanements, boarded nearly 25 percent of all the passengers in the United States. The top two airports, Chicago O'Hare Field and the Hartsfield Atlanta International Airport, enplaned nearly 70 million (over 10 percent) of the nation's commercial air travelers in 2002 (Fig. 1.6). Because of this wide range of size within the primary commercial service airport category, the NPIAS subcategorizes these airports into "hub" classifications.

It should be noted that the term "hub" used by the FAA in the NPIAS is very different than the term used by the airline industry. Whereas the airline industry uses the term "hub" as an airport where the majority of an airline's passengers. will transfer between flights to reach their ultimate destinations, the FAA defines hub strictly by the number of annual enplaned passengers to use the airport. Furthermore, if there is more than one airport in a **standard metropolitan statistical area (SMSA),** the total number of enplaned passengers of the airports within the SMSA is used to determine the airport's "hub" classification (Fig. 1-7).

	Rank	2000 total enplaned passengers	Rank	1990 total enplaned passengers	Percent change 1990-00
Atlanta, GA (Hartsfield Intl.)	1	38,255,778	3	22,665,665	69
Chicago, IL (O'Hare Intl.)	2	30,888,464	1	25,636,383	20
Dallas/Ft. Worth, TX (Dallas/Ft. Worth Intl.)	3	27,841,040	2	22,899,267	22
Los Angeles, CA (Los Angeles Intl.)	4	25,109,993	4	18,438,056	36
Denver, CO (Denver Intl.)	5	17,643,261	6	11,961,839	47
Phoenix, AZ (Phoenix Sky Harbor Intl.)	6	17,239,215	7	10,727,494	61
Detroit, MI (Wayne County)	7	16,929,968	9	9,903,078	71
Las Vegas, NV (McCarran Intl.)	8	16,738,909	18	7,796,218	115
Minneapolis, MN (Minneapolis-St. Paul Intl.)	9	16,710,197	16	8,837,228	89
San Francisco, CA (San Francisco Intl.)	10	16,664,399	5	13,474,929	24
Houston, TX (George Bush Intercontinental)	11	15,814,709	20	7,543,899	110
Newark, NJ (Newark)	12	15,205,447	10	9,853,925	54
St. Louis, MO (Lambert-St.Louis Muni.)	13	15,101,246	13	9,332,091	62
Orlando, FL (Orlando Intl.)	14	13,465,706	19	7,677,769	75
Seattle, WA (Seattle-Tacoma Intl.)	15	13,308,253	21	7,385,594	80
Miami, FL (Miami Intl.)	16	12,654,506	14	9,226,103	37
Boston, MA (Logan Intl.)	17	11,505,983	12	9,549,585	20
New York, NY (La Guardia)	18	11,425,705	8	10,725,465	7
Philadelphia, PA (Philadelphia Intl.)	19	10,973,074	24	6,970,820	57
New York, NY (John F. Kennedy Intl.)	20	10,648,410	11	9,687,068	10
Charlotte, NC (Douglas Muni.)	21	10,377,837	22	7,076,954	47
Cincinnati, OH (Greater Cincinnati)	22	9,962,765	32	3,907,625	155
Baltimore, MD (Baltimore-Washington Intl.)	23	8,979,425	29	4,420,425	103
Salt Lake City, UT (Salt Lake City Intl.)	24	8,700,973	25	5,388,178	61
Honolulu, HI (Honolulu Intl.)	25	8,684,893	15	9,002,217	-4
Pittsburgh, PA (Greater Pittsburgh)	26	8,650,976	17	7,912,394	9
San Diego, CA (San Diego Intl.-Lindbergh)	27	7,624,519	26	5,260,907	45
Tampa, FL (Tampa Intl.)	28	7,430,829	27	4,781,020	55
Miami/Ft. Lauderdale, FL (Ft. Lauderdale-Hollywood Intl.)	29	7,140,518	34	3,875,357	84
Washington, DC (Reagan National)	30	6,983,212	23	7,034,693	-1
Chicago, IL (Midway)	31	6,972,213	37	3,547,040	97
Washington, DC (Dulles Intl.)	32	6,349,323	28	4,440,592	43

Fig 1.6 Top 40 busiest U.S. airports in terms of passenger

Source from Norman J. Ashford, The McGraw Hill, 3rd Edition, 2013.

Number Airports	Airport Type	Percentage of All Enplanements	Percentage of Active GA Aircraft1
31	Large-Hub Primary	69.6	1.3
37	Medium-Hub Primary	19.3	2.9
74	Small-Hub Primary	7.7	4.7
280	Nonhub Primary	3.2	11.3
124	Other Commercial Service	0.1	2.0
260	Relievers	0.0	27.1
2,558	General Aviation	0.0	37.2
3,364	Existing NPIAS Airports	100.0	86.4
15,942	Low Activity Landing Areas (Non-NPIAS)	0.0	13.6

Fig.1.7 Airports by level of activity

1.9 Classification of Hubs

The hub classifications used by the FAA in the NPIAS are:

1. Large hubs
2. Medium hubs
3. Small hubs
4. Nonhubs

Large hubs are those airports that account for at least 1 percent of the total annual passenger enplanements in the United States. In 2002, there were 31 large hub airports in the NPIAS. These 31 large hub airports accounted for 70 percent of all passenger enplanements in the United States. **Medium hubs** are those airports that account for at least 0.25 percent but less than 1percent of the total annual passenger enplanements. In 2002, there were 37 airports classified as medium hubs. **Small hubs** are defined as those airports accommodating greater than 0.05 percent but less than 0.25 percent of annual U.S. enplanements. Seventy-four NPIAS airports were categorized as small hubs (Figure 1.8).

Non hubs are those airports that enplane at least 10,000 annual enplanements but less than 0.05 percent of the annual total U.S. enplanements. In 2002, 280 primary commercial service airports fell into the non hub category. Airports that handle at least 2,500 but less than 10,000 annual enplanements are categorized as non primary commercial service airports, or simply commercial service airports. In 2002, there were 124 non primary commercial service airports included in the NPIAS.

Fig.1.8 Hub and spoke route network

1.10 General aviation airports

Those airports with fewer than 2,500 annual enplaned passengers and those used exclusively by private business aircraft not providing commercial air carrier passenger service are categorized as **general aviation (GA) airports.** Although there are over 13,000 airports that fit this category, only a subset is included in the NPIAS. There is typically at least one general aviation airport in the NPIAS for every county in the United States. In addition, any general aviation airport that has at least 10 aircraft based at the airport and is located at least 20 miles away from the next nearest NPIAS airport is usually included in the NPIAS.

In 2002, a total of 2,558 general aviation airports were included in the NPIAS. Whereas commercial service airports accommodate virtually of the enplaned commercial passengers in the United States, general aviation airports account for the majority of aircraft operations. General aviation airports accommodate aviation operations of all kinds, from flight training, to aerial agricultural operations, to corporate passenger travel, to charter flights using the largest of civil aircraft. Pipeline patrol, search and rescue operations, medical transport, business.

The components of an airport

An airport is a complex transportation facility, designed to serve aircraft, passengers, cargo, and surface vehicles. Each of these users is served by different components of an airport. The components of an airport are typically placed into two categories. The **airside** of an airport is planned and managed to accommodate the movement of aircraft around the airport as well as to and from the air. The airside components of an airport are further categorized as being part of the local airspace or the airfield. The airport's **airfield** component includes all the facilities located on the physical property of the airport to facilitate aircraft operations. The **airspace** surrounding an airport is simply the area, off the ground, surrounding the airport, where aircraft maneuver, after takeoff, prior to landing, or even merely to pass through on the way to another airport. The **landside** components of an airport are planned and managed to accommodate the movement of ground-based vehicles, passengers, and cargo. These components are further categorized to reflect the specific users being served.

The airport **terminal** component is primarily designed to facilitate the movement of passengers and luggage from the landside to aircraft on the airside see figure 1.9.

The airport's **ground access** component accommodates the movement and executive flying in fixed-wing aircraft and helicopters, charters, air taxis, flight training, personal transportation, and the many other industrial commercial and recreational uses of airplanes and helicopters take advantage of general aviation airports. Similar to commercial service airports, general aviation airports vary widely in their characteristics. Many general aviation airports are small facilities, with typically a single runway long enough to accommodate only small aircraft, and are limited in their facilities. These small airports primarily serve as a base for a few aircraft.

Other general aviation airports have facilities and activity that rival their commercial service counterparts. These airports have multiple runways, at least one long enough to accommodate corporate and larger-size jet aircraft, and have a full spectrum of maintenance, fueling, and other service facilities. Many such general aviation airports even have rental car, restaurant, and hotel services to accommodate their customers.

A general aviation airport is generally categorized as being either a **basic utility** or **general utility facility.** Basic utility airports are designed to accommodate most single-engine and small twin-engine propeller-driven aircraft. These types of aircraft accommodate approximately 95 percent of the general aviation aircraft fleet. General utility airports can accommodate larger aircraft, as well as the lighter, smaller aircraft handled by basic utility airports.

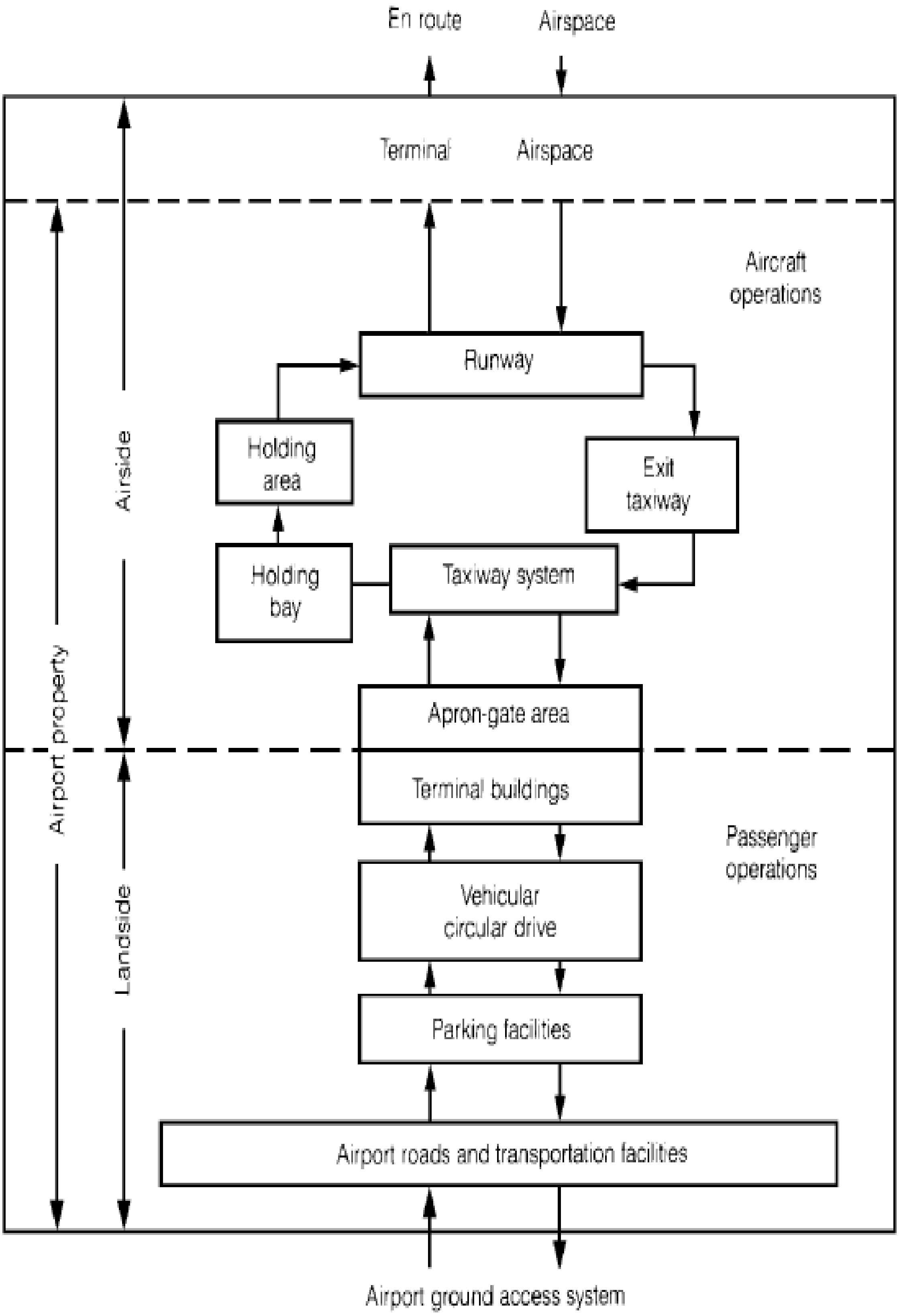

Fig1.9 The components of an airport.

TOP 50 U.S. AIRPORTS BASED ON ITINERANT GENERAL AVIATION OPERATIONS

Fiscal Year 2001

ID	FACILITY NAME	STATE	TOTAL AIRPORT OPS	ITINERANT GA OPS	AIR CARRIER OPS	AIR CARRIER% TOTAL
VNY	Van Nuys	CA	443,179	299,915	0	0.00%
DAB	Daytona Beach Int'l	FL	371,592	298,512	4,140	1.11%
TEB	Teterboro	NJ	267,794	202,538	179	0.07%
SFB	Orlando/Sanford	FL	393,027	170,644	6,279	1.60%
FXE	Fort Lauderdale Exec. Intl	FL	247,239	170,377	0	0.00%
BFI	Seattle/Boeing Field	WA	317,341	166,684	10,148	3.20%
LGB	Long Beach/Daugherty Field	CA	362,014	159,355	9,913	2.74%
MMU	Morristown	NJ	240,931	150,447	0	0.00%
DVT	Phoenix/Deer Valley	AZ	338,830	148,111	0	0.00%
SNA	Santa Ana/John Wayne	CA	385,742	147,933	85,568	22.18%
APA	Denver/Centennial	CO	365,379	147,124	0	0.00%
ORL	Orlando Executive	FL	207,367	143,294	0	0.00%
OAK	Metropolitan Oakland Int'l	CA	403,399	142,946	158,210	39.22%
PDK	Atlanta/DeKalb Peachtree	GA	214,011	137,349	0	0.00%
ADS	Dallas/Addison Field	TX	160,151	135,154	70	0.04%
CRQ	Carlsbad/McClellan Palomar	CA	232,252	134,861	0	0.00%
PTK	Pontiac/Oakland Co. Int'l	MI	296,897	134,797	602	0.20%
VRB	Vero Beach	FL	221,301	131,758	5	0.00%
FFZ	Mesa/Falcon Field	AZ	257,441	128,782	177	0.07%

Fig 1.8. Busiest 50 airports in terms of itinerant general aviation operations

Reliever airports

Reliever airports comprise a special category of general aviation airports. Reliever airports, generally located within a relatively short distance (less than 50 miles) of primary commercial service airports, are specifically designated by the NPIAS as "general aviation-type airports that provide relief to congested major airports." To be classified as a reliever airport, the airport must have at least 50 aircraft based at the airport or handle at least 25,000 itinerant operations or 35,000 local operations annually, either currently or within the last 2 years. Reliever airports are located within an SMSA with a population of at least 500,000 or where passenger enplanements at the nearest commercial service airport exceed 250,000 annually.

As the name suggests, reliever airports are intended to encourage general aviation traffic to use the facility rather than the busier commercial service airport, which may be experiencing delays, by providing facilities of similar quality and convenience to those available at the commercial service airports. In many major metropolitan areas, reliever airports account for a majority of airport operations. In the Atlanta, Georgia, SMSA, for example, the 11 designated reliever airports account for more operations than occur annually at the Hartsfield Atlanta International Airport, the nation's busiest commercial service airport. Of the general aviation airports recognized in the NPIAS, 260 have been classified as reliever airports. These airports are home to over 38 percent of all general aviation aircraft.

1.11 Organizations that influence airport regulatory policies

There are many national organizational and regional organizations that are deeply interested in the operation of airports. Most of these organizations are interested in developing and preserving airports because of their role in the national air transportation system and their value to the areas they serve. The primary goal of these groups is to provide political support for their causes with hopes to influence federal, state, and local laws concerning airports and aviation operations in their favor.
In addition, these groups provide statistics and informational publications and provide guest speakers and information sessions to assist airport management and other members of the aviation community in order to provide support for civil aviation. Each of these organizations is particularly concerned with the interests of their constituents; however there are numerous times when they close ranks and work together for mutual goals affecting the aviation community in general.

The following is a brief listing of the most prominent associations. A complete listing can be found in the *World Aviation Directory* published by McGraw-Hill. These organizations, by virtue of the alphabetic acronyms they are most commonly referred by, make up the "alphabet soup" of aviation-related support organizations.

• *Aerospace Industries Association (AIA)—founded 1919.* Member companies represent the primary manufacturers of military and large commercial aircraft, engines, accessories, rockets, spacecraft, and related items.

• *Aircraft Owners & Pilots Association (AOPA)—founded 1939.* With almost 400,000 members, AOPA represents the interests of general aviation pilots. AOPA provides insurance plans, flight planning, and other services, as well as sponsors large fly-in meetings. In addition the AOPA's Airport Support network plays a large role in the support and development of all airports, with particular support to smaller general aviation airports.

• *Air Line Pilots Association (ALPA)—founded 1931.* The Air Line Pilots Association is the oldest and largest airline pilots' union, supporting the interests of the commercial pilots and commercial air carrier airports.

• *Airports Council International—North America (ACI–NA)—founded 1991.* First established as the Airport Operators Council in 1947, the ACI–NA considers itself the "voice of airports" representing local, regional, and state governing bodies that own and operate commercial airports throughout the United States and Canada. As of 2003, 725 member airports throughout belong to ACI–NA. The mission of the ACI–NA is to identify, develop, and enhance common policies and programs for the enhancement and promotion of airports and their management that are effective, efficient, and responsive to consumer and community needs.

• *Air Transport Association of America (ATA)—founded 1936.* The ATA represents the nation's certificated air carriers in a broad spectrum

• *American Association of Airport Executives (AAAE)—founded 1928.* A division of the Aeronautical Chamber of Commerce at its inception, the AAAE became an independent entity in 1939. Membership includes individual representatives from airports of all sizes throughout the United States, as well as partners in the aviation industry and academia.

• *Aviation Distributors and Manufacturers Association (ADMA)—founded 1943.* Represents the interests of a wide variety of aviation firms including fixed-base operators (FBOs) who serve general aviation operations and aircraft component part manufacturers. The ADMA is a strong proponent of aviation education.

• *Experimental Aircraft Association (EAA)—founded 1953.* The EAA, with over 700 local chapters, promotes the interests of homebuilt and sport aircraft owners. EAA hosts two of the world's largest fly-in conventions each year, at Oshkosh, Wisconsin, and Lakeland, Florida. • *Flight Safety Foundation (FSF)—founded 1947.* The primary function of the FSF is to promote air transport safety. Its members include airport and airline executives and consultants.

• *General Aviation Manufacturers Association (GAMA)—founded 1970.* GAMA's members include manufacturers of general aviation aircraft, engines, accessories, and avionics equipment. GAMA is a strong proponent of general aviation airports.

• *Helicopter Association International (HAI)—founded 1948.* Members of HAI represent over 1,500 member organizations in 51 countries that operate, manufacture, and support civil helicopter operations.

• *International Air Transport Association (IATA)—founded 1945.* IATA is an association of more than 220 international air carriers whose main functions include coordination of airline fares and operations. IATA annually assesses international airports for their service quality and publishes their findings industry wide.

• *National Agricultural Aviation Association (NAAA)—founded 1967.*As the voice of the aerial application industry, NAAA represents the interests of agricultural aviation operators. The NAAA represents over1,250 members including owners of aerial application businesses; pilots; manufacturers of aircraft, engines, and equipment; and those in related businesses.

• *National Air Transportation Association (NATA)—founded 1941.* First known as the National Aviation Training Association and later Trades Association, NATA represents the interests of fixed-base operators, air taxi services, and related suppliers and manufacturers.

1.12 The airport organization chart

An **organization chart** shows the formal authority relationships between superiors and subordinates at various levels, as well as the formal channels of communication within the organization. It provides a framework within which the management functions can be carried out. The chart aids employees to perceive more clearly their positions in the organization in relation to others and how and where managers and workers fit into the overall organizational structure. Airport management organization charts range from the very simple to the very complex, depending primarily on the size, ownership, and management structure of the airport.

The organization chart is a static model of an airport's management structure; that is, it shows how the airport is organized at a given point in time. This is a major limitation of the chart, because airports operate in a dynamic environment and thus must continually adapt to changing conditions. Some old positions might no longer be required, or new positions might have to be created in order that new objectives can be reached; therefore, it is necessary that the chart be revised and updated periodically to reflect these changing conditions.

The duties, policies, and theories that govern the job of airport management vary widely over time. In addition, many such policies vary from airport to airport on the basis of individual airport operating characteristics. As a result, it is difficult to say that any organization chart is typical or that the chart of one airport at any particular time is the one still in effect even a few months later; however, all airports do have certain common functional areas into which airport activities are divided.

Understandably, the larger the airport, the greater the specialization of tasks and the greater the departmentalization. Figure 1.9 shows the major functional areas and typical managerial job titles for a commercial airport.

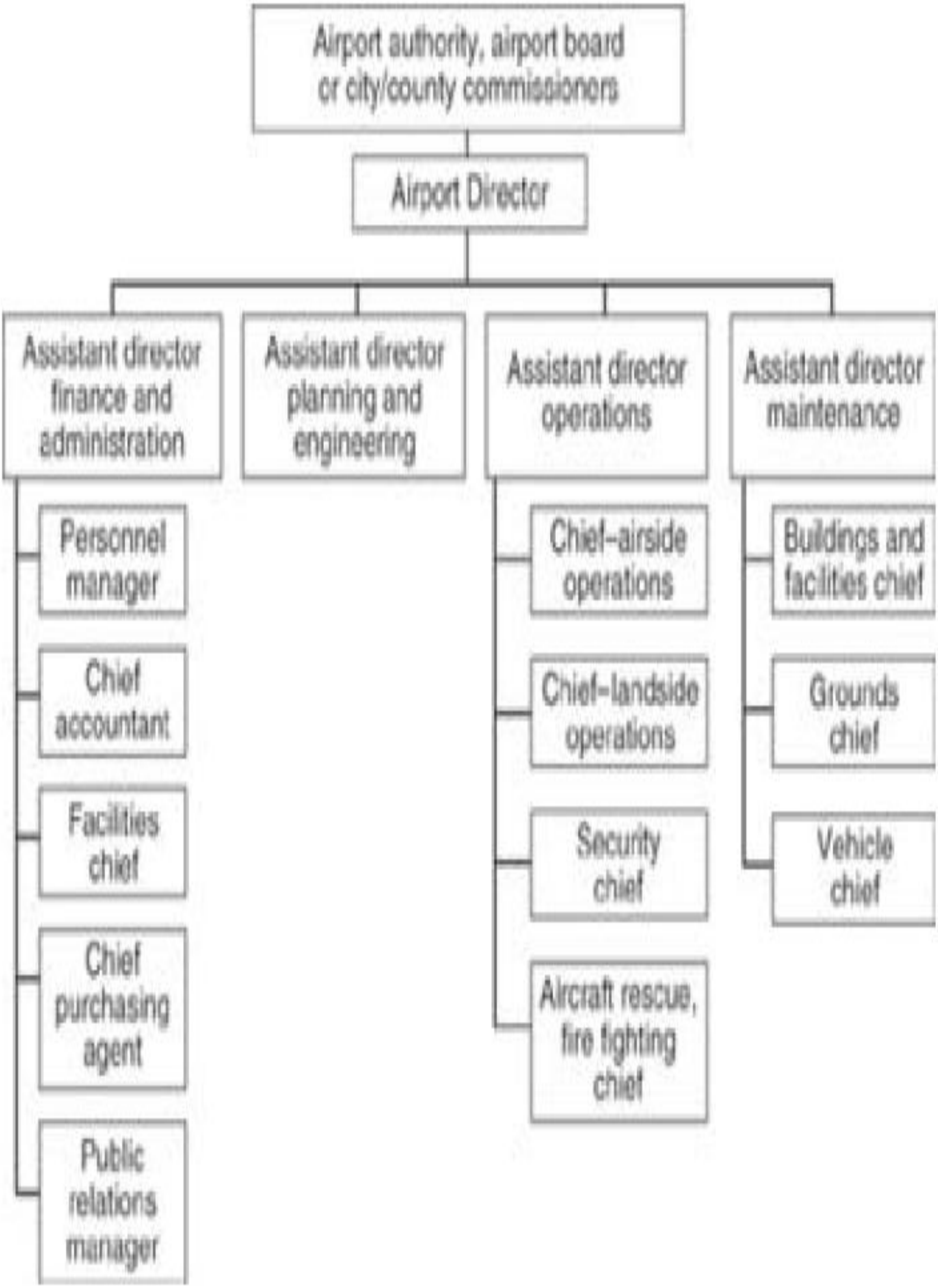

Fig 1.9 *Typical airport management organization chart*

Runways

Perhaps the single most important facility on the airfield is the **runway.** After all, without a properly planned and managed runway, desired aircraft would be unable to use the airport. Regulations regarding the management and planning of runway systems are some of the most comprehensive and strict in airport management.

For example, strict design guidelines must be followed when planning runways, with particular criteria for the length, width, orientation (direction), configuration (of multiple runways), slope, and even pavement thickness of runways, as well as the immediate airfield area surrounding the runways to assure that there are no dangerous obstructions preventing the safe operation of aircraft.

Runway operations are facilitated by systems of markings, lighting systems, and associated airfield signage that identify runways and provide directional guidance for aircraft taxiing, takeoff, approach, and landing. Strict regulations regarding the use of runways, including when and how the aircraft may use a runway for takeoff and landing, are imposed on airfield operations.

Runway orientation

When the Wright brothers made their first flight at Kitty Hawk in 1903, there were no runways to facilitate the flight. However, certain conditions existed during the flight that led directly to the orientation of today's runways. The Wright brothers knew that, since fixed-wing aircraft rely on airflow over the aircraft's wings to achieve flight, the appropriate direction to take off an aircraft was into whichever way the wind was blowing. This allows aircraft to achieve the desired amount of airflow over the wings with the least amount of ground speed and takeoff distance. Similarly, the safest direction in which to land an aircraft is also into the wind. As a result of this physical property of aircraft, airport runways are typically oriented into the prevailing winds of the area. While many airports have runways that are oriented in different directions, the runway(s) that is oriented into the prevailing winds is known as the **primary runway(s)** see figure 1.10**.**

Fig.1.10 Flagler County Airport in Bunnell

Runway pavements

In 1903, the relatively light weight of the Wright brothers' first flyer allowed the aircraft, and all other aircraft of the time, the ability to operate on grass. Even today, many of the lighter aircraft in use have the ability to take off and land on any of the hundreds of grass runways that exist. However, with the creation of heavier aircraft, it became necessary to stabilize and strengthen the runway environment.

Today, virtually all commercial service airports have at least one paved runway to accommodate the full fleet of commercial and general aviation aircraft.

Runways may be constructed of **flexible (asphalt)** or **rigid (concrete)** materials. Concrete, a rigid pavement that can remain useful for 20 to 40 years, is typically found at large commercial service airports and former military base airfields. Runways made of rigid pavements are typically constructed by aligning a series of concrete slabs connected by joints that allow for pavement contraction and expansion as a result of the loading of aircraft on the pavement surface, and as a result of changes in air temperature. Runways constructed from flexible pavement mixtures are typically found at most smaller airports. Flexible pavement runways are typically much less expensive to construct than rigid pavement runways. The life of asphalt runways typically lasts between 15 and 20 years, given proper design, construction, and maintenance.

Runway markings

There are three types of markings for runways: visual, non precision instrument, and precision instrument. These marking types reflect the types of navigational aids associated with assisting aircraft on approach to land on the runway. A visual runway is intended solely for aircraft operations using visual approach procedures. A non precision instrument runway is one having an instrument approach procedure using air navigation facilities with only horizontal guidance for which a *straight-in* non precision instrument approach procedure has been approved by the FAA. For detail see figure 1.11.

A precision instrument runway is one having an instrument approach procedure using a precision instrument landing system (e.g., ILS) or precision approach radar (PAR) that provides both horizontal and vertical guidance to the runway.

Visual, non precision, and precision instrument runway markings include runway designators and centerlines. Non precision instrument runways also include runway threshold markings and aiming points (used be called fixed-distance markers).

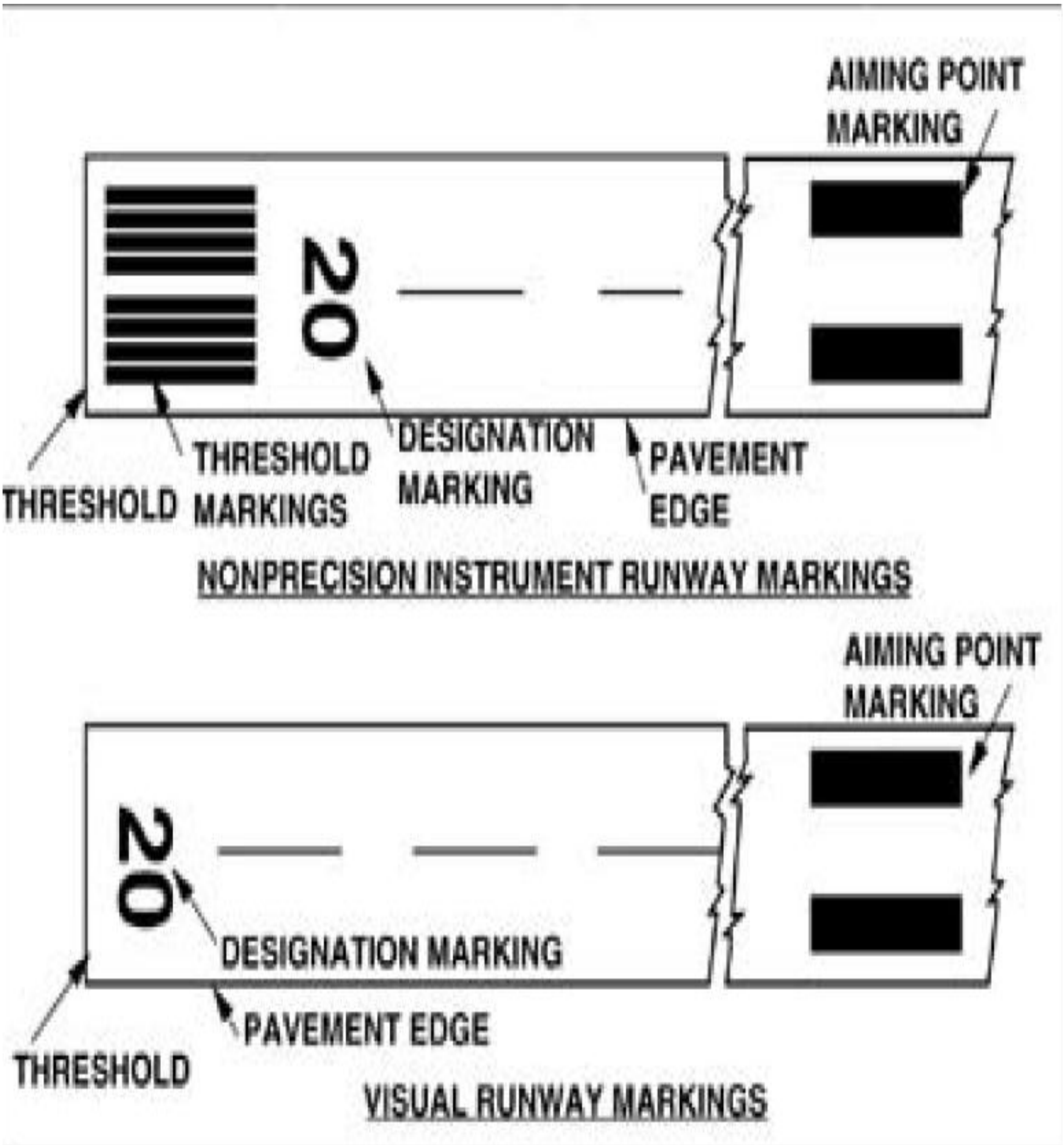

Fig 1.11 Visual and non precision runway markings

Runway designators identify the name of the runway by the runway's orientation. The runway number is the whole number nearest one-tenth the magnetic azimuth of the centerline of the runway, measured clockwise from magnetic north. The letters differentiate among left (L), right (R), or center (C) parallel runways, as applicable.

Runway centerlines identify the center of the runway and provide alignment guidance during takeoff and landings. The centerline consists of a line of uniformly spaced stripes and gaps.

Runway threshold markings help identify the beginning of the runway that is available for landing. In some instances, the landing threshold may be *relocated* or *displaced* up the runway from the actual beginning of pavement. Runway threshold markings come in two configurations. They either consist of eight longitudinal the runway centerline or the number of stripes is related to the width of the runway. Table relates runway width to the number of runway threshold marking stripes of uniform dimension disposed symmetrically.

Table 4-1. Number of Runway Threshold Stripes

Runway Width, ft (m)	Number of Stripes
60 (18)	4
75 (23)	6
100 (30)	8
150 (45)	12
200 (60)	16

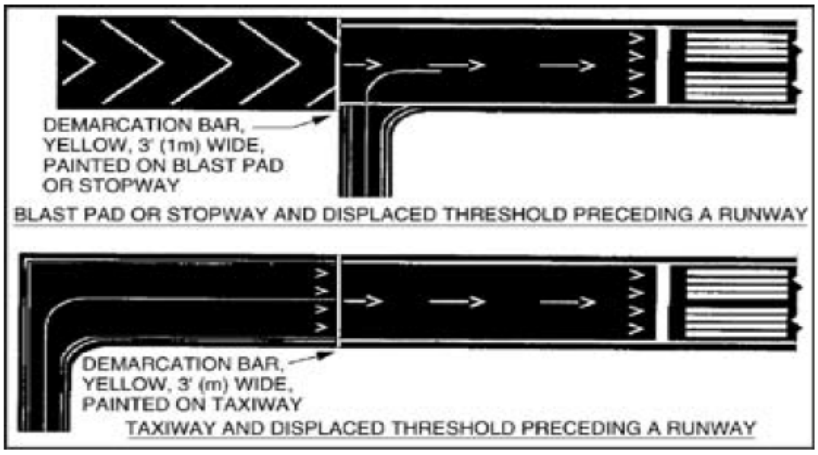

Fig 1.12 Displaced threshold markings

Runway lighting

Runway lighting is extremely important for nighttime aircraft operations or in poor visibility weather conditions. Runway lighting systems are placed into three categories, approach lighting systems, visual glide slope indicators, runway end identifiers, runway edge light systems, and in-runway lighting systems.

As their names imply, approach lighting systems aid aircraft in properly aligning with the runway on approach to landing, and in-runway lighting systems aid aircraft in landing and takeoff operations on and in the immediate vicinity of the runway.

Approach lighting systems

Approach lighting systems (ALS) provide the basic means for aircraft to identify runways when operating in poor weather conditions and when operating under IFR. ALS are a configuration of signal lights starting at the landing threshold and extending back from the runway, called the *approach area*, a distance of 2,400 to 3,000 feet for precision instrument runways and 1,400 to 1,500 feet for non precision instrument runways.

Some systems include sequenced flashing lights which appear to the pilot as a ball of light traveling toward the runway at high speed (Fig. 1.13). The following approach lighting systems are in use at civil airports in the United States (Fig. 1.14): *ALSF-1:* Approach light system 2,400 feet in length with sequenced flashing lights in ILS Cat-I configuration (see further in this section for a full description of ILS).

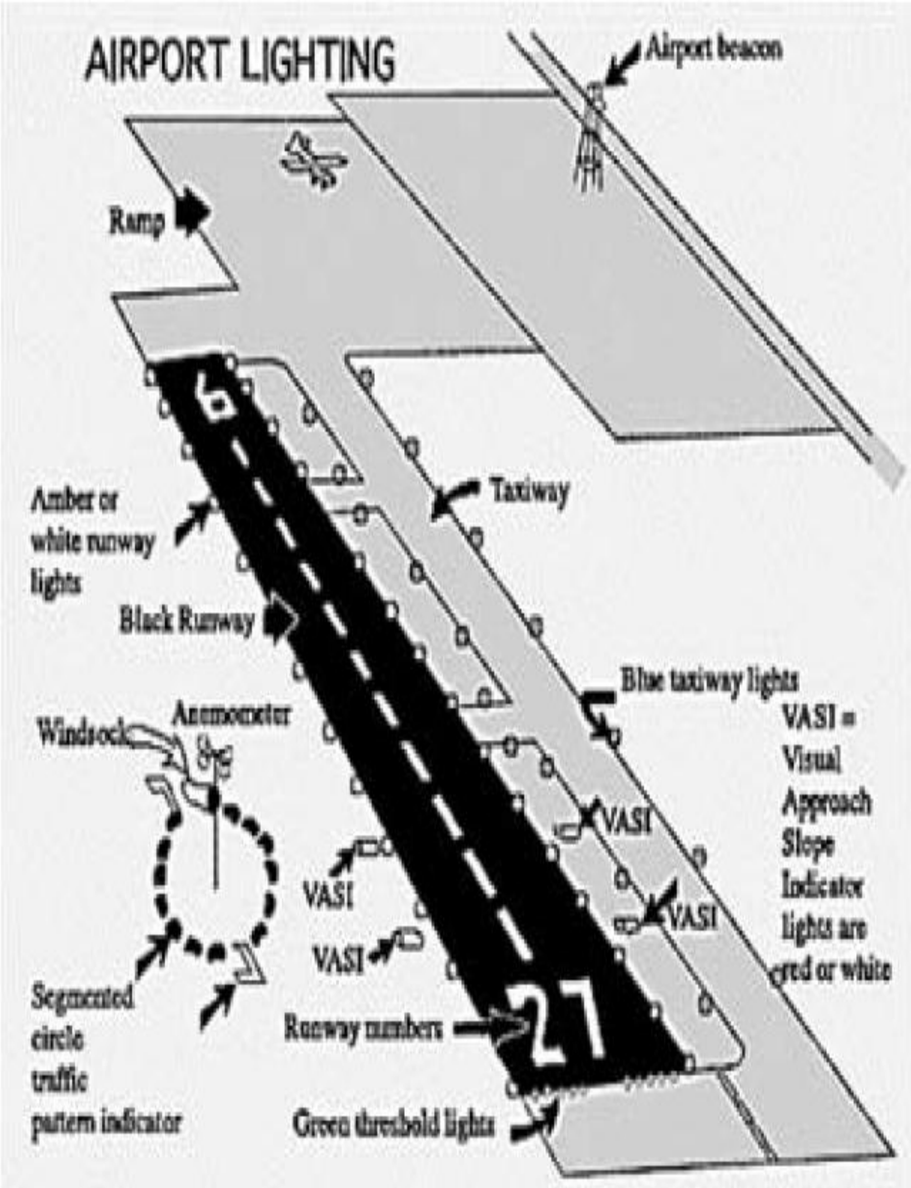

Fig 1.13 *Overview of airport lighting systems*

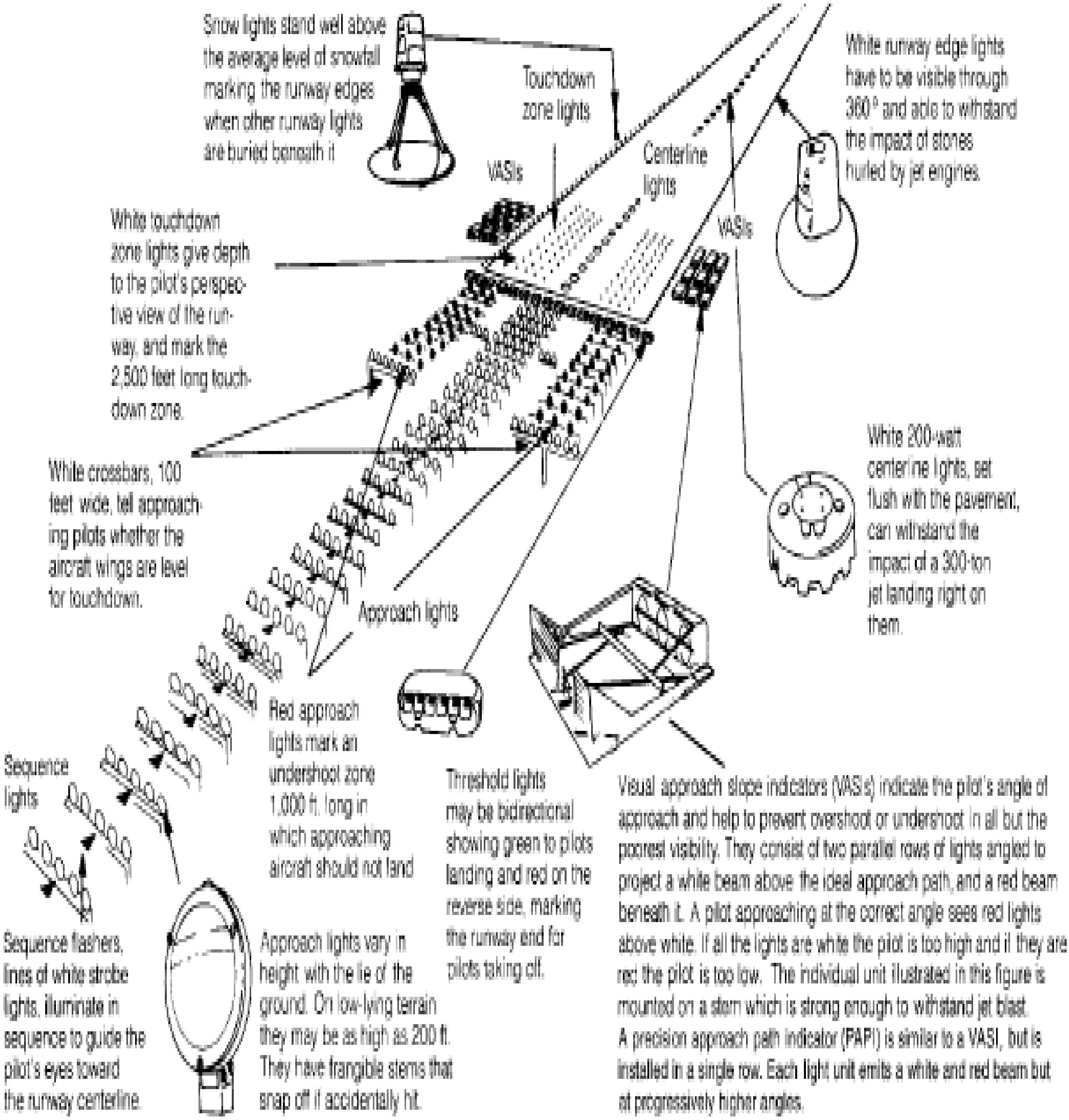

Fig 1.14 Precision approach lighting system

UNIT-II
GROUND HANDLING AND BAGGAGE HANDLING

2.1 Introduction

The passenger and cargo terminals have been described as interface points between the air and ground modes, the movement of passengers, baggage, and cargo through the terminals and the turnaround of the aircraft on the apron are achieved with the help of those involved in the ground handling activities at the airport (IATA 2012). These activities are carried out by some mix of the airport authority, the airlines, and special handling agencies depending on the size of the airport and the operational philosophy adopted by the airport operating authority. For convenience of discussion, ground handling procedures can be classified as either terminal or airside operations.

2.2 Passenger Handling

Passenger handling in the terminal is almost universally entirely an airline function or the function of a handling agent operating on behalf of the airline. In most countries of the world, certainly at the major air transport hubs, the airlines are in mutual competition. Especially in the terminal area, the airlines wish to project a corporate image, and passenger contact is almost entirely with the airline, with the obvious exceptions of the governmental controls of health, customs, and immigration. Airline influence is perhaps seen at its

Terminal

Baggage check
Baggage handling
Baggage claim
Ticketing and check-in
Passenger loading/unloading
Transit passenger handling
Elderly and disabled persons
Information systems
Government controls
Load control
Security Cargo

Airside
Ramp services
Supervision
Marshaling Startup
Moving/towing aircraft
Safety measures

On-ramp aircraft servicing

Repair of faults Fueling
Wheel and tire check
Ground power supply Deicing

Cooling/heating
Toilet servicing
Potable water
De-mineralized water
Routine maintenance
Non routine maintenance
Cleaning of cockpit windows, wings, nacelles, and cabin windows

Onboard servicing cleaning
Catering
In-flight entertainment
Minor servicing of cabin fittings
Alteration of seat configuration

External ramp equipment
Passenger steps
Catering loaders
Cargo loaders
Mail and equipment loading
Crew steps on all freight aircraft

Extreme in the United States, where individual airlines on occasion construct facilities In these circumstances, the airlines play a significant role in the planning and design of physical facilities that they will operate. Even where there is no direct ownership of facilities, industry practice involves the designation of various airport facilities that are leased to the individual airlines operating these areas. Long-term designation of particular areas to an individual airline results in a strong projection of airline corporate image, particularly in the ticketing and check-in areas and even in the individual gate lounges.

A more common arrangement worldwide is for airlines to lease designated areas in the terminal, but to have a large proportion of the ground handling in the ramp area carried out by the airport authority, a special handling agency, or another airline. At a number of international airports, the airline image is considerably reduced in the check-in area when common-user terminal equipment (CUTE) is used to connect the check-in clerk to the airline computers.

Apron passenger-transfer vehicles are usually of the conventional bus type Both airline and airport ownership and operation are common, airline operation being economically feasible only where the carrier has a large number of movements.

1.3 Ramp Handling

During the period that an aircraft is on the ground, either in transit or on turnaround, the apron is a center of considerable activity (IATA 2004). Some overall supervision of activities is required (ICAO 2010) to ensure that there is sufficient coordination of operations to avoid unnecessary ramp delays. This is normally carried out by a ramp coordinator or dispatcher who monitors departure control. Marshaling is provided to guide the pilot for the initial and final maneuvering of the aircraft in the vicinity of its parking stand position. Marshaling includes the positioning and removal of wheel chocks, landing-gear locks, engine blanking covers, Pitot covers, surface control locks, cockpit steps, and tail steadies. Headsets are provided to permit ground-to-cockpit communication, and all necessary electrical power for aircraft systems is provided from a ground power unit. When the aircraft is to spend an extended period on the ground, the marshaling procedure includes arranging for remote parking or hangar space. The ramp handling process also includes the provision, positioning, and removal of the appropriate equipment for engine starting purposes. It shows an engine air-start power unit suitable for providing for a large passenger aircraft.

Safety measures on the apron include the provision of suitable firefighting equipment and other necessary protective equipment, the provision of security personnel where required, and notification of the carrier of all damage to the aircraft that is noticed during the period that the aircraft is on the apron.

2.4 Aircraft Ramp Servicing

Most arriving or departing aircraft require some ramp services, a number of which are the responsibility of the airline station engineer. When extensive servicing is required, many of the activities must be carried out simultaneously.

Fault Servicing
Minor faults that have been reported in the technical log by the aircraft captain and that do not necessitate withdrawal of the aircraft from service are fixed under supervision of the station engineer.

Fueling

The engineer, who is responsible for the availability and provision of adequate fuel supplies, supervises the fueling of the aircraft, ensuring that the correct quantity of uncontaminated fuel is supplied in a safe manner. Supply is either by mobile truck systems to ensure competitive pricing from suppliers and to give maximum flexibility of apron operation. Oils and other necessary equipment fluids are replenished during the fueling process.

Wheels and Tires
A visual physical check of the aircraft wheels and tires is made to ensure that no damage has been incurred during the last takeoff/ landing cycle and that the tires are still serviceable.

Ground Power Supply

Although many aircraft have auxiliary power units (APUs) that can provide power while the aircraft is on the ground, there is a tendency for airlines to prefer to use ground electrical supply to reduce fuel costs and to cut down apron noise. At some airports, the use of APUs is severely restricted on environmental grounds. Typically, ground power is supplied under the supervision of the station engineer by a mobile unit.

Cooling/Heating

In many climates where an aircraft is on the apron for some time without operation of the APU, auxiliary mobile heating or cooling units are necessary to maintain a suitable internal temperature in the aircraft interior. The airline station engineer is responsible for ensuring the availability of such unit
Where fixed air systems are used, cockpit controls can ensure either internal heating or cooling on an individual aircraft basis depending on the requirement. Studies indicate that the high cost of running air-craft APUs now means that fixed air systems can completely recover capital costs from the savings of

two years of normal operation. Where airlines have infrequent flights to an airport, APUs are still used.

Other Servicing

Toilet holding tanks are serviced externally from the apron by special mobile pumping units. De-mineralized water for the engines and potable water are also replenished during servicing.

Onboard Servicing

While external aircraft servicing is being carried out, there are simultaneous onboard servicing activities, principally cleaning and catering.

Very high levels of cabin cleanliness are achieved by

- Exchange of blankets, pillow, and headrests
- Vacuuming and shampooing of carpets
- Clearing of ashtrays and removal of all litter
- Restocking of seatback pockets
- Cleaning and restocking of galleys and toilets
- Washing of all smooth areas, including armrests

Catering

Personnel clear the galley areas immediately after disembarkation of the incoming passengers. After the galley has been cleaned, it is restocked, and a secondary cleaning takes care of spillage during restocking. Internationally agreed standards of hygiene must be met in the handling of food and drink from their point of origin to the passenger.

2.5 Ramp Layout

During the design phase of a commercial air transport aircraft, considerable thought is given to the matter of ramp ground handling. Modern aircraft are very large, complicated, and expensive. Therefore, the apron servicing operation is also complicated and consequently time-consuming. Unless the ramp servicing procedure can be performed efficiently, with many services being carried out concurrently, the aircraft will incur long apron turnaround times during which no productive revenue is earned. Inefficient ramp servicing can lead to low levels of aircraft and staff utilization and a generally low level of airline productivity. It can be seen that the aircraft door and servicing-point layout has been arranged to permit simultaneous operations during the short period that the vehicle is on the ground during turnaround service. The ramp coordinator is required to ensure that suitable equipment and staff numbers are available for the period the aircraft is likely to be on the ground.

Particular attention must be paid to the compatibility of apron handling devices with the aircraft and other apron equipment. The sill height of the aircraft must be compatible with passenger and freight loading systems. In the case of freight, there is the additional directional compatibility requirement. Transporters must be able to load and unload at both the aircraft and the terminal onto beds and loading devices that are compatible with the vehicles' direction of handling. Many transporters can load or unload in the one direction only. The receiving devices must be oriented to accept this direction.
Most mobile equipment requires frequent maintenance. In addition to normal problems of wear, mobile apron equipment is subject to increased damage from minor collisions and misuse that do not occur in

the same degree with static equipment. Successful apron handling might require a program of preventive maintenance on apron equipment and adequate backup in the inevitable case of equipment failure. Safety in the ramp area is also a problem requiring constant attention. The ramps of the passenger and cargo terminal areas are high-activity locations with much heavy moving equipment in a high-noise environment. Audible safety cues, such as the noise of an approaching or backing vehicle, are frequently not available to the operating staff members, who are likely to be wearing ear protection. Very careful training of the operating staff is required, and strict adherence to designated safety procedures is necessary to prevent serious accidents (IATA 2012; CAA 2006).

2.6 Departure Control

The financial effects of aircraft delay fall almost entirely on the airline. The impact of delays in terms of added cost and lost revenue can be very high. Consequently, the functions of departure control, which monitors the conduct of ground handling operations on the ramp (not to be confused with ATC departure), are almost always kept under the control of the airline or its agent. Where many of the individual ground handling functions are under the control of the airport authority, there also will be general apron supervision by the airport authority staff to ensure efficient use of authority equipment.

The ramp coordinator in charge of departure control frequently must make decisions that trade off payload and punctuality. Effect of breakdown and delay on apron dispatch: (a) activity normal, no control action; delay through breakdown, control required. Action 1: Assess the nature of the problem and how long the problem (breakdown of the cargo loader) will take to sort out. Action 2: Take corrective action immediately or call equipment base and ask the engineer to come to the aircraft immediately or call up a replacement loader. Action 3: Advise all other sections/activities that will be affected by the breakdown. Give them instructions as necessary (e.g., notify movement control of a delay, tell passenger service to delay boarding, etc.).

1.7 Division of Ground Handling Responsibilities

There is no hard-and-fast rule that can be applied to the division of responsibility for ground handling functions at airports. The responsibility varies not only from country to country but also among airports in the same country.

Prior to airline deregulation, handling activities were carried out mainly by airlines (acting on their own behalf or for another airline) or the airport authority. At many non-U.S. airports, all handling tasks were undertaken by the airport authority (e.g., Frankfurt, Hong Kong, and Singapore). The converse was almost universally true in the United States. Virtually all airport ground handling was carried out by the airlines. (In the old Soviet Union, all aviation activities were the responsibility of one organization, Aeroflot. This included the functions of the civil aviation authority, the airline, and the airports.)
Since deregulation, there has been a general movement toward liberalization and the introduction of competition in airport operations. In the mid-1990s, the European Union introduced regulations that required airports to use two or more ground handing operators where the scale of operation made this economic (EC 1996). This policy has been mirrored all around the world. Specialist companies are now providing some or all ground handling services at most large and medium-sized airports. In some facilities, the airlines still prefer to use their own staff where there is major contact between the company and the public. Ticketing, check-in, and lounge services are retained by the airline, but on the ramp, functions such as marshaling, steps, loading and unloading of baggage and cargo, and engine

starts are carried out by the handling companies.

2.8 Control of Ground Handling Efficiency

The extreme complexity of the ground handling operation requires skilled and dexterous management to ensure that staff and equipment resources are used at a reasonable level of efficiency. As in most management areas, this is achieved by establishing a system of control that feeds back into the operation when inefficiencies appear. The method of control used at any individual airport depends on whether the handling is carried out by the airline itself, by a handling agency such as another airline, or by the airport authority.

Four major reporting tools help to determine whether reasonable efficiency is being maintained and permit the manager to discern favorable and unfavorable operational changes.

Monthly complaint report. Each month, a report is prepared that shows any complaints attributable to ground handling problems. The report contains the complaint, the reason behind any operational failure, and the response to the complainant.

Monthly punctuality report. Each month, the manager in charge of ground handling prepares a report of all delays attributable to the ground handling operation. In each case, the particular flight is identified, with its scheduled and actual time of departure. The reason for each delay is detailed. The monthly summary should indicate measures taken to preclude or reduce similar future delays. Typical aircraft servicing standards are 30 to 60 minutes for a transit operation and 90 minutes for a turnaround. Where LCC operations are involved, these times may be reduced considerably.

Cost analysis. The actual handling organization will, at least on a quarterly basis, analyze handling costs. These costs should include capital and operating costs.

General operational standards

To ensure an overall level of operational acceptability, periodic inspections of operations and facilities must be made. This is especially important for airlines carrying out their own handling away from their main base or at airports where they are handled by other organizations. For the airport operation, it is equally important. In all areas possible, the evaluation should be carried out using quantitative measures. Subjective measures should be avoided because they are not constant between evaluators and may not be constant over time even with a single evaluator.

2.9 General

Ground handling of a large passenger aircraft requires much specialized handling equipment, and the total handling task involves considerable staff and labor inputs. Good operational performance implies a high standard of equipment serviceability. In northern climates, it is usual to assume that equipment will be serviceable for 80 percent of the time during the winter and 85 percent during the summer. Backup equipment and maintenance staff must be planned for the periods of unserviceability.

Passenger services: Security

Personal search or scan efficiency Hand baggage search efficiency Inconvenience level and waiting times passenger services: escort and boarding

Effectiveness of directions and announcements Staff availability for inquiries at waiting and boarding points Assistance at governmental control points Control of boarding procedure Liaison level between check-in and cabin staff Service levels of special waiting lounges for premium ticket holders Special handling: Minors, handicapped

Passenger services: Arrivals Staff to meet flight

Information for terminating and transfer passengers Transfer procedures
Assistance through government control points Special passenger handling: Minors, handicapped Baggage delivery standards Assistance at baggage delivery Passenger services: Delayed/diverted/canceled flights Procedures for information to passengers Procedures for greeters
Messages including information to destination and en-route points Procedures for rerouting and surface transfers Meals, refreshments, and hotel accommodations.
Passenger services: Baggage facilities Compilation of loss or damage reports Baggage tracing procedures Claims and complaints procedures Passenger services: Equipment

Check security and condition of all equipment: Scales, reservations printer, seat plan stand, ticket printer, credit-card imprinter, calculators, etc. Condition and serviceability of ramp vehicles Serviceability and appearance of ramp equipment Maintenance of ramp equipment and vehicles Control of ramp equipment and vehicles Driving standards and safety procedures
Communications: Telephones, ground-air radio, ground-ground radio Ramp handling: Aircraft loading/unloading Care of aircraft exteriors, interiors, and unit load devices Adequacy of loading instructions and training Ramp equipment planning and availability Positioning of equipment to aircraft Loading and unloading supervision Securing, restraining, and spreading loads Operation of load equipment Operation of aircraft onboard systems Securing partial loads Ramp security Ramp safety Pilferage and theft Ramp handling: Cleaning/catering Standard of cockpit and cabin cleaning/dressing Toilet/potable-water servicing Catering loading/unloading Availability of ground air Air-jetty operations

Ramp handling: Load control (for airline only)
Load sheet accuracy and adequacy of presentation Load planning
Advance zero-fuel calculation and flight preparation Ramp handling: Aircraft dispatch Punctuality record Turnaround/transit supervision Passenger release from aircraft Passenger waiting time at boarding point Logs and message files Accuracy of records of actual departure times Right plan, dispatch meteorological information

2.10 Ramp handling: Post departure

Accuracy and time of dispatch of post departure records and messages Cargo handling: Export Acceptance procedures Documentation: Procedures and accuracy Reservations: Procedures and performance Storage: Procedures and performance Makeup of loads: Procedures and performance check weighing
Palletization and containerization: Procedures and performance Cargo handling: Import
Breakdown of pallets/containers: Procedures and performance
Customs clearance of documents
Notification of consignees
Dwell time of cargo
Lost/damaged cargo procedures
Proof of delivery procedures
Handling of dangerous goods procedures
Handling of restricted goods procedures
Handling of valuable consignments procedures
Handling of live animals procedures
Handling of mail
Administration of ground handling Office appearance Furniture and equipment condition

Inventory records: Ramp equipment/vehicles/office equipment/furniture Budgeting: Preparation and monitoring.

2.11. Implications of Variations in Volumes

It can be easily demonstrated that the demand for peak-hour schedules affects the amount of infrastructure that must be supplied by the airport. Whereas the need to implement service in an off-peak period will not necessarily involve the airport in significant marginal costs, at a crowded airport, the decision to take another service in the peak hour might well add significant marginal costs. There are, however, economies of scale that result from peak-hour operations. Figure 2.1 a and b, shows the relationship between passenger flows and air-carrier aircraft operations. It can be seen that whereas passenger volumes vary significantly between peak and nonpeak hours, the same scale of variation is not observed in aircraft movement volumes. This reflects the fact that during off-peak periods, aircraft operate at lower load factors than during the attractive peak-hour slots. The implications in terms of costs and revenues need to be considered. Services such as ramp handling, emergency services, air traffic control, runway and taxiway handling, and even some terminal services (e.g., announcements and baggage check) are based on the aircraft unit rather than on the number of passengers it carries. In off-peak hours, these services are provided at a less economic rate per passenger than during peak periods owing to low load factors during off peak periods. Therefore, the airport is faced with a dilemma. Although peak operations would appear to involve high marginal costs in terms of infrastructure, operation at close to peak volumes is highly economic once this infrastructure is provided. There is even a temptation for the airport to operate at flow levels above the design rate. This inevitably leads to reduced LOS in terms of processing delays and overcrowding.

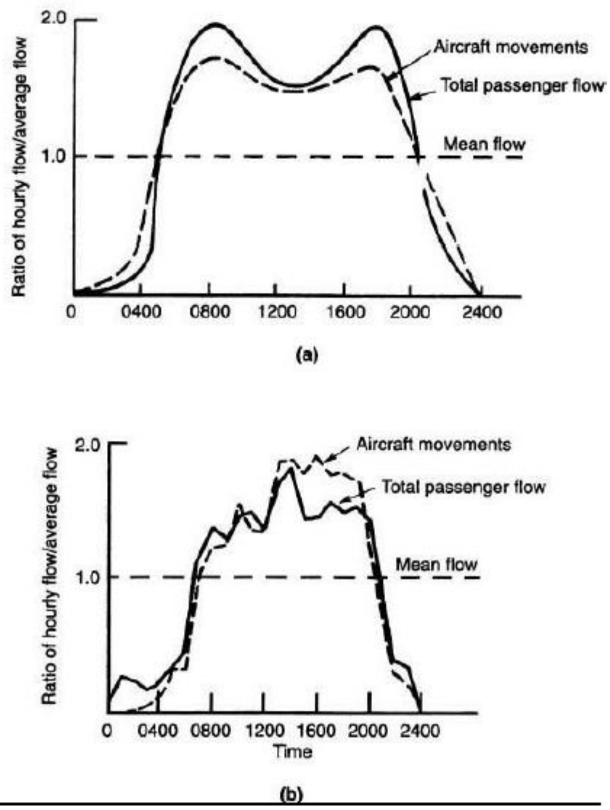

Fig. 2. 1. a) Idealized relationship between air carrier movements and passenger flow.
(b) Observed relationship between air traffic movements and passenger flow at Chicago

1.12. Factors and Constraints on Airline Scheduling Policies

The development of a schedule, especially at a major hub with capacity problems, is a complex problem for the airline. The process involves considerable skill and a clear understanding of company policies and operating procedures. Among the factors to be considered, the following are most important. Utilization and Load Factors Aircraft are expensive items of equipment that can earn revenues only when being flown. Clearly, all other factors being equal, high utilization factors are desirable. However, utilization alone cannot be used as the criterion for schedule development; it must be accompanied by high load factors. Without the second element, aircraft would be scheduled to fly at less than breakeven passenger payloads, which typically are close to 70-57 percent on long-haul operation of a modern wide-bodied aircraft.

Reliability

No airline would attempt to schedule using the sole criterion of maximizing utilization of aircraft. Utilization can be maximized, however, subject to the double constraints of load factors and punctuality. As attempted utilization increases, the reliability of the service will suffer in terms of punctuality. Schedule adherence is a function of two random variables: equipment serviceability and late arrivals or departures of aircraft owing to en-route factors. Computer models are used to predict the effect of schedules on punctuality, and the result is compared with target levels of punctuality set in advance for each season. Long-Haul Scheduling Windows A schedule must take into account the departure and arrival times at the various airports at origin, en route, and at destination. In 2012, Qantas offered a service between London and Sydney that called at Frankfurt, Singapore, and Melbourne. Leaving London at 1830, the flight first called at Frankfurt 2115/2350, local time, avoiding the landing ban at Frankfurt from 0100/0400. The next stop on the following day was Singapore, 1800/1945, on the evening of the next day, followed by a call at Melbourne, 0500/0645, the morning of the day after that. The final leg of the flight landed at Sydney at 0810, well after the end of the night curfew, which ran from 2300 to 0600. If the same service were to be attempted with a schedule to land at Sydney at least an hour and 20 minutes before the beginning of the curfew, it would have to leave London at 0800 two days before. This is a poor time to begin a long flight because of problems accessing London Airport at such an early hour. Departure times must be set recognizing that many passengers must travel from city centers to the airport and must arrive at the airport some reasonable time before the scheduled time of departure. The landing time at Sydney also gives too small a margin for error. Figure 2.2provides examples of scheduling windows for flights to and from London.

Eastbound transatlantic flights from New York JFK to London Heathrow take approximately seven hours, and there is a time difference of five hours between the two cities. The Heathrow night jet ban, which has few exceptions, commences at 0000 hours and ends at 0600 hours. Eastbound flights are therefore scheduled to take off before 1200 hours or after 1800 hours. Zurich has a no-exception night jet ban between 2300 hours and 0600 hours. Eastbound flights from New York JFK must leave either before 0900 hours or after

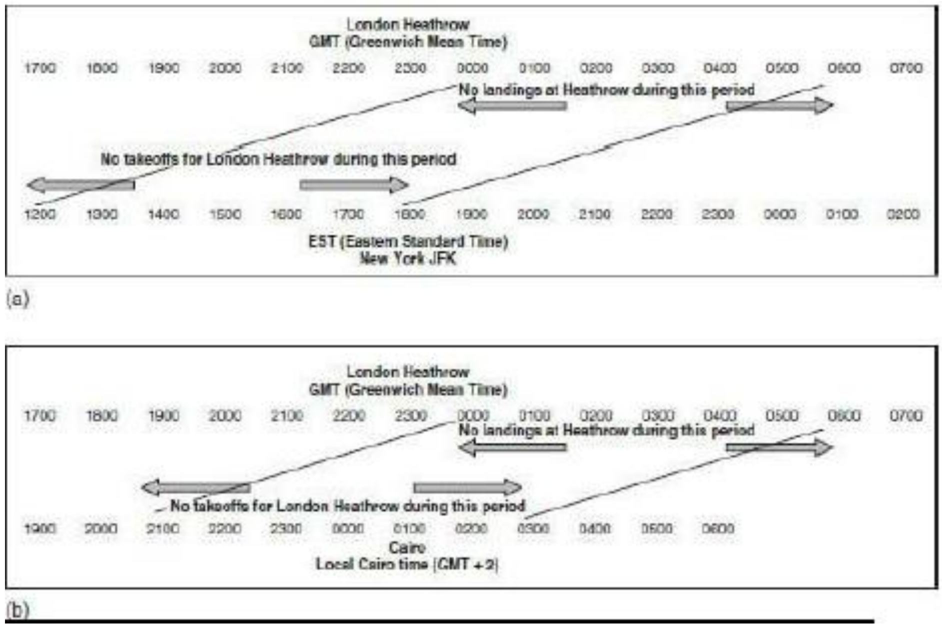

FIGURE 2.2 Scheduling windows for eastbound and westbound flights into London Heathrow Airport.

2.13 Ground Handling

Introduction

The passenger and cargo terminals have been described as interface points between the air and ground modes (Ashford et al. 2011). The position of the terminals within the general system has been shown conceptually in Figure 2.1, and the actual flows within the terminals in the more detailed system diagrams of passenger and cargo terminals are shown in Figures 2.2, respectively. Within the context of these diagrams, the movement of passengers, baggage, and cargo through the terminals and the turnaround of the aircraft on the apron are achieved with the help of those involved in the ground handling activities at the airport (IATA 2012). These activities are carried out by some mix of the airport authority, the airlines, and special handling agencies depending on the size of the airport and the operational philosophy adopted by the airport operating authority. For convenience of discussion, ground handling procedures can be classified as either terminal or airside operations. Such a division, however, is only a convention in that the staff and activities involved are not necessarily restricted to these particular functional areas. Table 2.1 lists the airport activities normally classified under ground handling operations. The remainder of this chapter deals with these activities, but for convenience, the major areas of baggage handling, cargo, security, and load control have been assigned to other chapters to permit a more extensive discussion of these items.

Terminal	
Baggage check	
Baggage handling	
Baggage claim	
Ticketing and check-in	
Passenger loading/unloading	
Transit passenger handling	
Elderly and disabled persons	
Information systems	
Government controls	
Load control	
Security	
Cargo	
Airside	
Ramp services	
	Supervision
	Marshaling
	Startup
	Moving/towing aircraft
	Safety measures
On-ramp aircraft servicing	
	Repair of faults
	Fueling
	Wheel and tire check
	Ground power supply
	Deicing
	Cooling/heating
	Toilet servicing
	Potable water
	Demineralized water
	Routine maintenance
	Nonroutine maintenance
	Cleaning of cockpit windows, wings, nacelles, and cabin windows
Onboard servicing cleaning	
	Catering
	In-flight entertainment
	Minor servicing of cabin fittings
	Alteration of seat configuration
External ramp equipment	
	Passenger steps

Table 2.1 The Scope of Ground Handling Operations

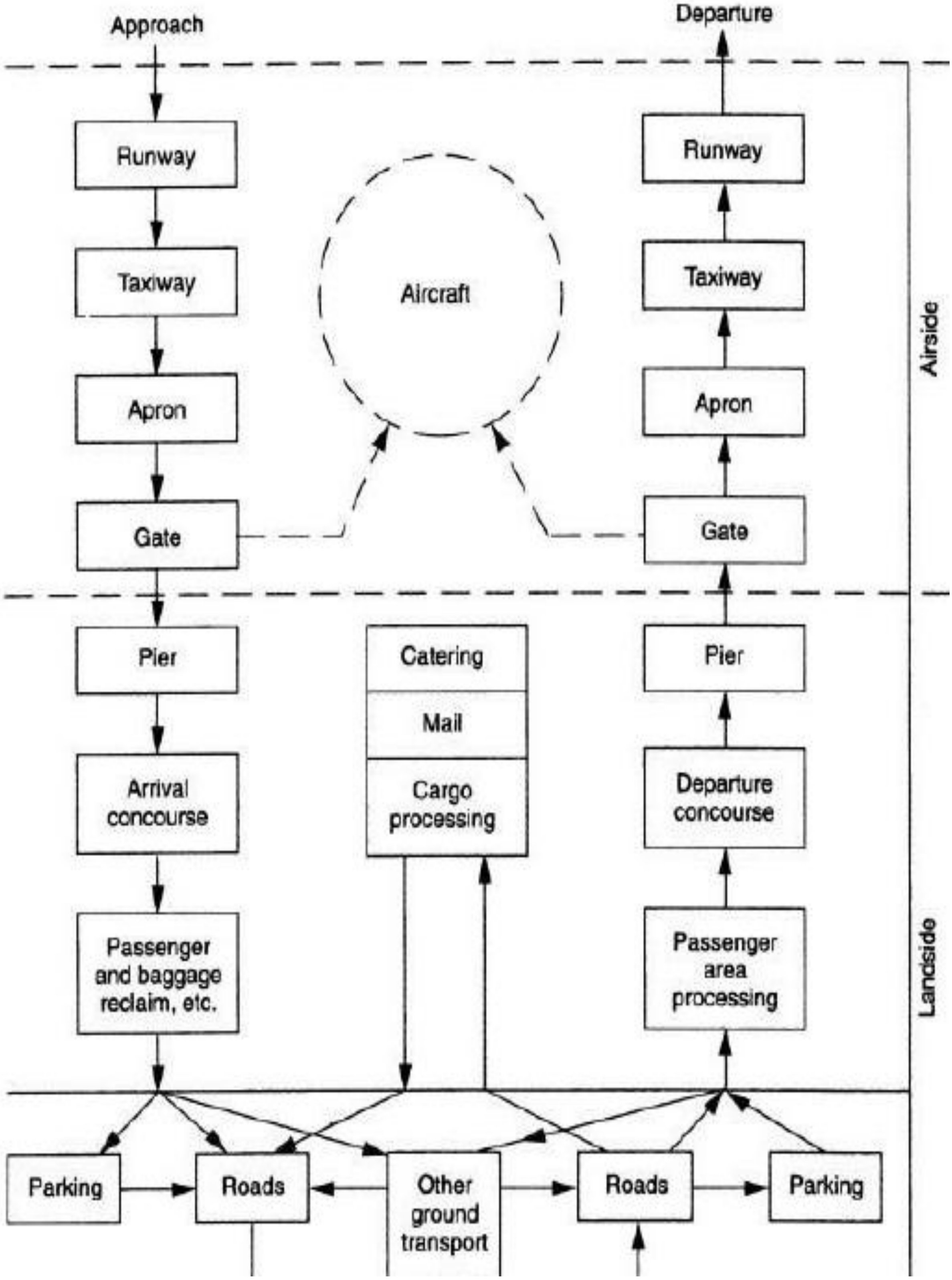

Fig 2.1 The airport system

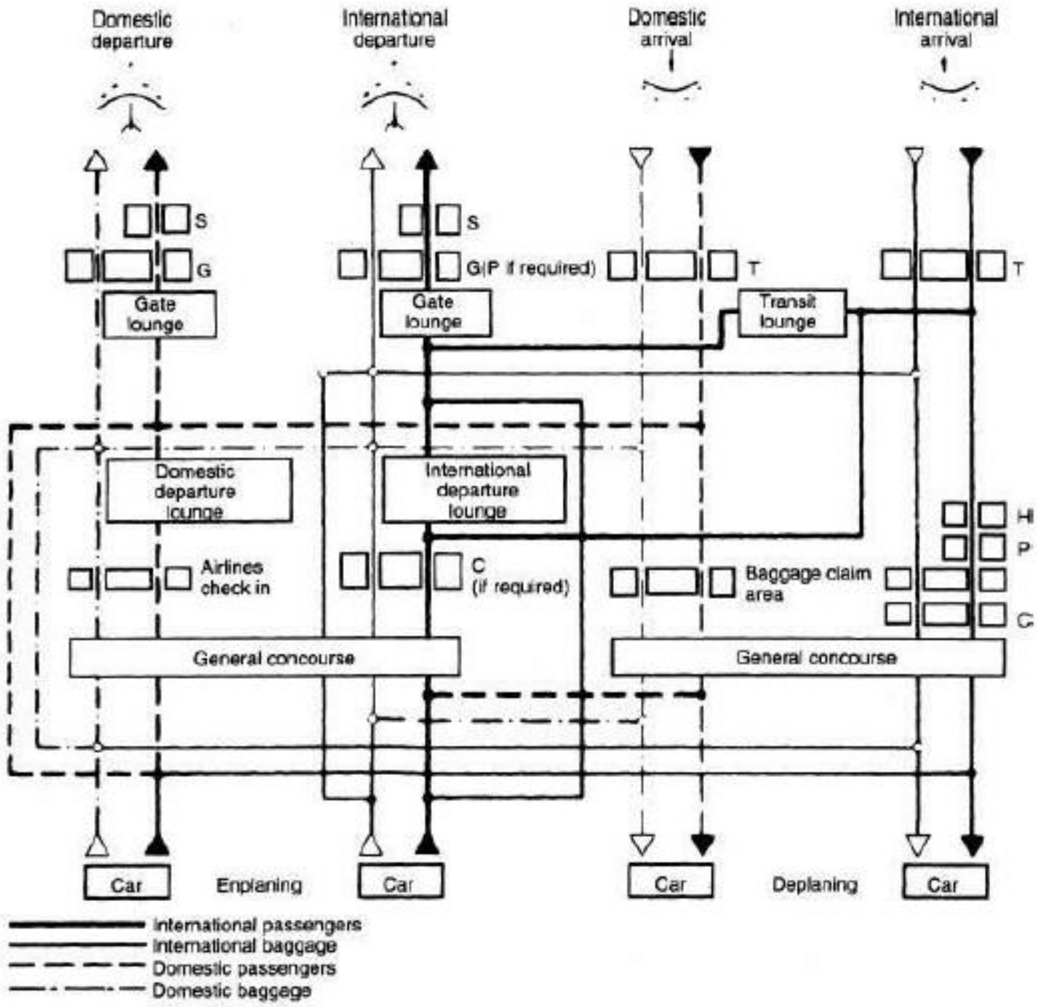

Fig 2.2 Schematic of the passenger baggage flow system

2.14 Passenger Handling

Passenger handling in the terminal is almost universally entirely an airline function or the function of a handling agent operating on behalf of the airline. In most countries of the world, certainly at the major air transport hubs, the airlines are in mutual competition. Especially in the terminal area, the airlines wish to project a corporate image, and passenger contact is almost entirely with the airline, with the obvious exceptions of the governmental controls of health, customs, and immigration. Airline influence is perhaps
seen at its extreme in the United States, where individual airlines on occasion construct facilities (e.g., the old United terminal and the new Jet Blue terminals at New York JFK). In these circumstances, the airlines play a significant role in the planning and design of physical facilities that they will operate. Even where there is no direct ownership of facilities, industry practice involves the designation of various airport facilities that are leased to the individual airlines operating these areas. Long-term designation of particular areas to an individual airline results in a strong projection of airline corporate image, particularly in the ticketing and checkin areas and even in the individual gate lounges

A more common arrangement worldwide is for airlines to lease designated areas in the terminal, but to have a large proportion of the ground handling in the ramp area carried out by the airport authority, a special handling agency, or another airline. At a number of international airports, the airline image is considerably reduced in the checkin area when common-user terminal equipment (CUTE) is used to connect the checkin clerk to the airline computers. Use of the CUTE system can substantially reduce the requirements for numbers of checkin desks, particularly where there is a large number of airlines and some airlines have very light service schedules or the airline presence is not necessary throughout the whole day. Desks are assigned by resource managers on a need basis. Checkin areas are vacated by one airline and taken up by another based on departure demand. The airline's presence at checkin desks is displayed on overhead logo panels that are activated when an airline logs onto the CUTE system (Figure 2.3). Common Use Self Service or CUSS is a shared kiosk offering checkin facilities to passengers without the need for ground staff. The CUSS kiosks can be used by several participating airlines in a single terminal.

Fig 2.3 Computer-assigned CUTE passenger checkin desks at Munich Airport

The airside passenger-transfer steps (Figure 2.4) and loading bridges (Figure 2.5) might be operated by the airline on a long-term leasing arrangement or by the airport authority or handling agency at a defined hiring rate to the airlines. With the advent of very large aircraft (e.g., the A380), multiple loading bridges are required to cope with passenger flows to and from a single aircraft .They require experienced handling, but even these are normally operated by the airlines.

Fig. 2.4 Airline passenger steps

Fig 2.5 Elevating passenger air bridge

Apron passenger-transfer vehicles are usually of the conventional bus type. Both airline and airport ownership and operation are common, airline operation being economically feasible only where the carrier has a large number of movements. Figure 2.6 shows a typical airport-owned apron bus. Where a more sophisticated transfer vehicle, such as the mobile lounges shown in Figure 2.7 are used, it is usual for the operation to be entirely in the hands of the airport authority.

Fig.2.6 Apron passenger transport bus.

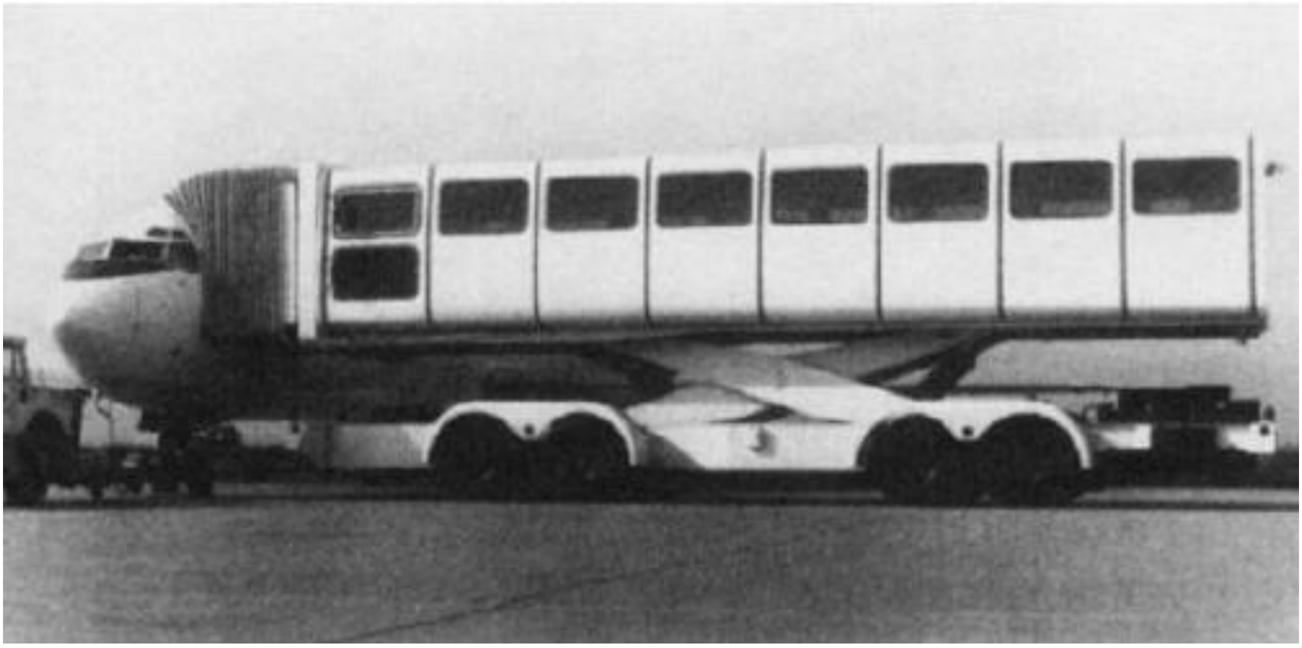

Fig 2.7 Mobile lounge for passenger transport across the apron

2.15 Ramp Handling

During the period that an aircraft is on the ground, either in transit or on turnaround, the apron is a center of considerable activity (IATA 2004). Some overall supervision of activities is required (ICAO 2010) to ensure that there is sufficient coordination of operations to avoid unnecessary ramp delays. This is normally carried out by a ramp coordinator or dispatcher who monitors departure control. Marshaling is provided to guide the pilot for the initial and final maneuvering of the aircraft in the vicinity of its parking stand position. In the delicate process of positioning the aircraft, the pilot is guided by internationally recognized hand signals from a signalperson positioned on the apron (Figure 2.8). Where nose-in docking is used next to a building, self-docking guides such as the Aircraft Parking and Information System (APIS) using optical moiré technology or the Docking Guidance System (DGS) using sensor loops in the apron pavement enabling the pilot to bring the aircraft to a precise location to permit the use of loading bridges (Ashford et al. 2011). Marshaling includes the positioning and removal of wheel chocks, landing-gear locks, engine blanking covers, pitot covers, surface control locks, cockpit steps, and tail steadies. Headsets are provided to permit ground-to-cockpit communication, and all necessary electrical power for aircraft systems is provided from a ground power unit. When the aircraft is to spend an extended period on the ground, the marshaling procedure includes arranging for remote parking or hangar space.

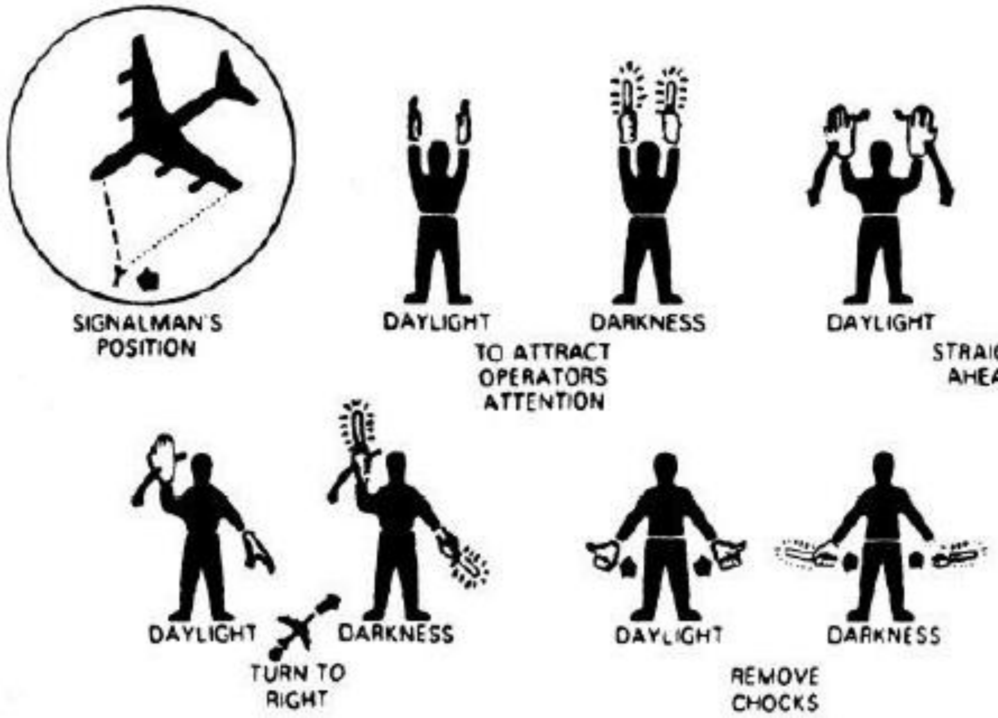

Fig 2.8 Ground signalman marshalling an aircraft. (Courtesy: IATA.)

Safety measures on the apron include the provision of suitable firefighting equipment and other necessary protective equipment, the provision of security personnel where required, and notification of the carrier of all damage to the aircraft that is noticed during the period that the aircraft is on the apron. Frequently there is a necessity for moving an aircraft, requiring the provision and operation of suitable towing equipment. Tow tractors might be needed simply for pushing out an aircraft parked in a nose-in position or for more extensive tows to remote stands or maintenance areas. A tractor suitable for moving a large passenger aircraft. It is normal aircraft-design practice to ensure that undercarriages are sufficiently strong to sustain towing forces without structural damage. Tow tractors must be capable of moving aircraft at a reasonable speed [12 mi/h (20 km/h) approximately] over considerable taxiway distances. As airports grow larger and more decentralized in layout, high-speed towing vehicles capable of operating in excess of 30 mi/h (48 km/h) have been developed, although speeds of 20 mi/h (32 km/h) are more common. Usually aircraft that are being towed have taxiway priority once towing has started. Therefore, reasonable tow speeds are necessary to avoid general taxiing delays.

Aircraft Ramp Servicing

Most arriving or departing aircraft require some ramp services, a number of which are the responsibility of the airline station engineer. When extensive servicing is required, many of the activities must be carried out simultaneously. Fault Servicing Minor faults that have been reported in the technical log by the aircraft captain and that do not necessitate withdrawal of the aircraft from service are fixed under supervision of the station engineer.

Fueling

The engineer, who is responsible for the availability and provision of adequate fuel supplies, supervises the fueling of the aircraft, ensuring that the correct quantity of uncontaminated fuel is supplied in a safe manner. Supply is either by mobile truck (bowser; Figure 2.9) or from the apron hydrant system (Figure 2.12). Many airports use both systems to ensure competitive pricing from suppliers and to give maximum flexibility of apron operation. Oils and other necessary equipment fluids are replenished during the fueling process.

Wheels and Tires

A visual physical check of the aircraft wheels and tires is made to ensure that no damage has been incurred during the last takeoff/ landing cycle and that the tires are still serviceable.

Ground Power Supply

Although many aircraft have auxiliary power units (APUs) that can provide power while the aircraft is on the ground, there is a tendency for airlines to prefer to use ground electrical supply to reduce fuel costs and to cut down apron noise. At some airports, the use of APUs is severely restricted on environmental grounds. Typically, ground power is supplied under the supervision of the station engineer by a mobile unit. Many airports also can supply power from central power supplies that connect to the aircraft either by apron cable or by cable in the air-bridge structure.

Fig 2.9 Mobile apron fuel tanker

Fig 2.10 Mobile aircraft fuel dispenser for fueling from apron hydrant system.

Deicing and Washing

Figure 2.11 shows a typical multiuse vehicle suitable for spraying the fuselage and wings with deicing fluid and for washing the aircraft, especially the cockpit windows, wings, nacelles, and cabin windows. This self-propelled tanker unit provides a stable lift platform for spraying or for various maintenance tasks on conventional and wide-bodied aircraft. Apron drainage facilities must permit the recapture and recycling of deicing fluid (ICAO)

Fig 2.11 Deicing/washer vehicle

Cooling/Heating

In many climates where an aircraft is on the apron for some time without operation of the APU, auxiliary mobile heating or cooling units are necessary to maintain a suitable internal temperature in the aircraft interior. The airline station engineer is responsible for ensuring the availability of such units. With increasing fuel costs and environmental concern, much interest has been focused on centralized compressed-air units delivering air to the aircraft gate positions (usually called fixed air supply or preconditioned air, (Figure 2.12) and to mobile compressors at the gates (known simply as compressed-air systems). Pneumatic systems can deliver high pressure air for both heating and cooling and for air-starting the engines. Where fixed air systems are used, cockpit controls can ensure either internal heating or cooling on an individual aircraft basis depending on the requirement. Studies indicate that the high cost of running aircraft APUs now means that fixed air systems can completely recover capital costs from the savings of two years of normal operation. Where airlines have infrequent flights to an airport, APUs are still used.

Fig 2.12 Fixed ground cooling unit attached to an air bridge

Other Servicing

Toilet holding tanks are serviced externally from the apron by special mobile pumping units. De-mineralized water for the engines and potable water are also replenished during servicing. Onboard Servicing While external aircraft servicing is being carried out, there are simultaneous onboard servicing activities, principally cleaning and catering. Very high levels of cabin cleanliness are achieved by

- Exchange of blankets, pillow, and headrests
- Vacuuming and shampooing of carpets
- Clearing of ashtrays and removal of all litter
- Restocking of seatback pockets
- Cleaning and restocking of galleys and toilets
- Washing of all smooth areas, including armrests Catering

Personnel clear the galley areas immediately after disembarkation of the incoming passengers. After the galley has been cleaned, it is restocked, and a secondary cleaning takes care of spillage during restocking. Internationally agreed standards of hygiene must be met in the handling of food and drink from their point of origin to the passenger. Where route stations are unable to meet either quality or hygiene standards, catering supplies are often brought from the main base. Figure 2.13 shows the loading operation of a catering truck. These trucks are usually constructed from a standard truck chassis with a closed-van body that can be lifted up by a hydraulic scissor lift powered by the truck engine. Two different types of catering trucks are available: low-lift vehicles suitable for servicing narrow-bodied aircraft up to 11.5 feet (3.5 m) doorsill height and high-lift vehicles for loading wide-bodied jets.

Fig 2.13 Catering truck in loading position.

2.17 Ramp Layout

During the design phase of a commercial air transport aircraft, considerable thought is given to the matter of ramp ground handling. Modern aircraft are very large, complicated, and expensive. Therefore, the apron servicing operation is also complicated and consequently time-consuming. Unless the ramp servicing procedure can be performed efficiently, with many services being carried out concurrently, the aircraft will incur long apron turnaround times during which no productive revenue is earned. Inefficient ramp servicing can lead to low levels of aircraft and staff utilization and a generally low level of airline productivity. The complexity of the apron operation becomes obvious when Figure 2.14 is examined. This figure shows the apron positions typically designated for servicing and loading equipment for a Boeing 747. It can be seen that the aircraft door and servicing-point layout has been arranged to permit simultaneous operations during the short period that the vehicle is on the ground during turnaround service. The ramp coordinator is required to ensure that suitable equipment and staff numbers are available for the period the aircraft is likely to be on the ground.

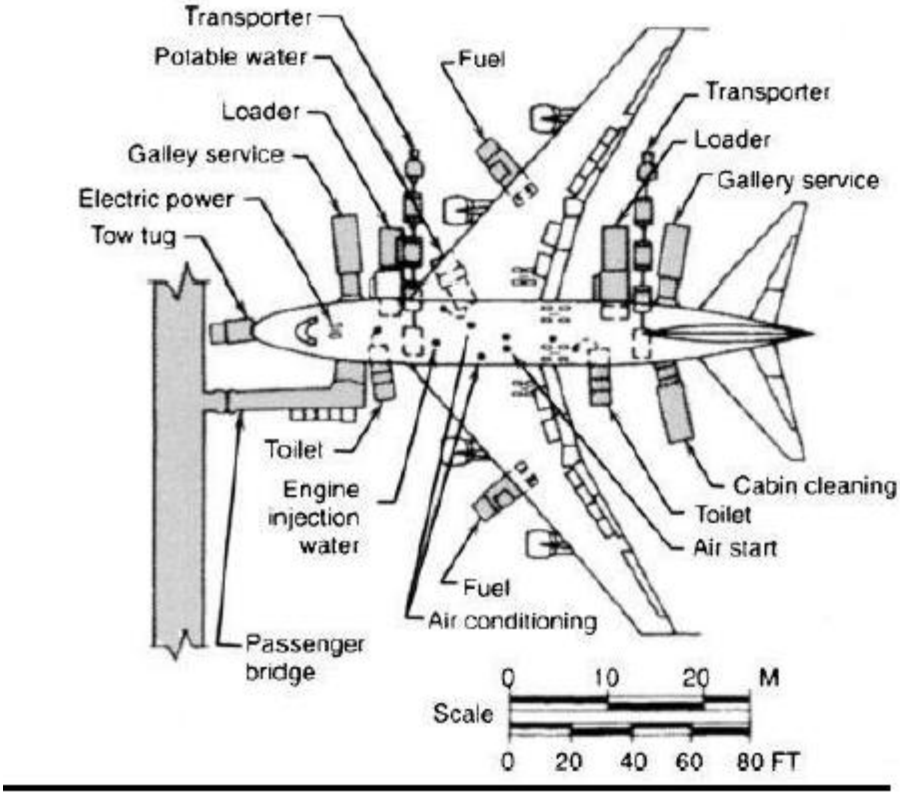

Fig 2.14 Ramp layout for servicing a B747SP.

Departure Control

The financial effects of aircraft delay fall almost entirely on the airline. The impact of delays in terms of added cost and lost revenue can be very high. Consequently, the functions of departure control, which monitors the conduct of ground handling operations on the ramp (not to be confused with ATC departure), are almost always kept under the control of the airline or its agent. Where many of the individual ground handling functions are under the control of the airport authority, there also will be general apron supervision by the airport authority staff to ensure efficient use of authority equipment. The complexity of a ramp turnaround of an aircraft is indicated by the critical-path diagram shown in Figure 2.15. Even with the individual servicing functions shown in simple form, it is apparent that many activities occur simultaneously during the period the aircraft is on the ramp. This functional complication is a reflection of the physical complexity found on the ramp.

The ramp coordinator in charge of departure control frequently must make decisions that trade off load and punctuality. Figure 2.15shows the effect of intervention by departure control in the case of cargo loading equipment breakdown. Figure 2.16 indicates satisfactory completion of a task within a scheduled turnaround time of 45 minutes. Figure 2.16 shows a 10-minute delay owing to equipment breakdown being reduced to a final ramp delay of only 5 minutes by the decision not to load nonrevenue airline company stores.

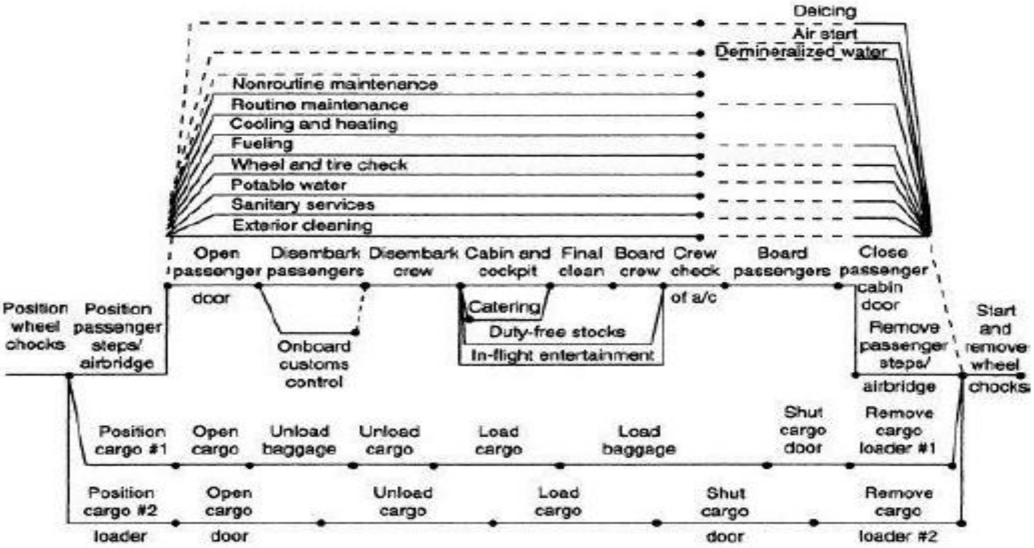

Fig 2.15 **C**ritical path of turnaround ground handling for a passenger transport aircraft taking cargo

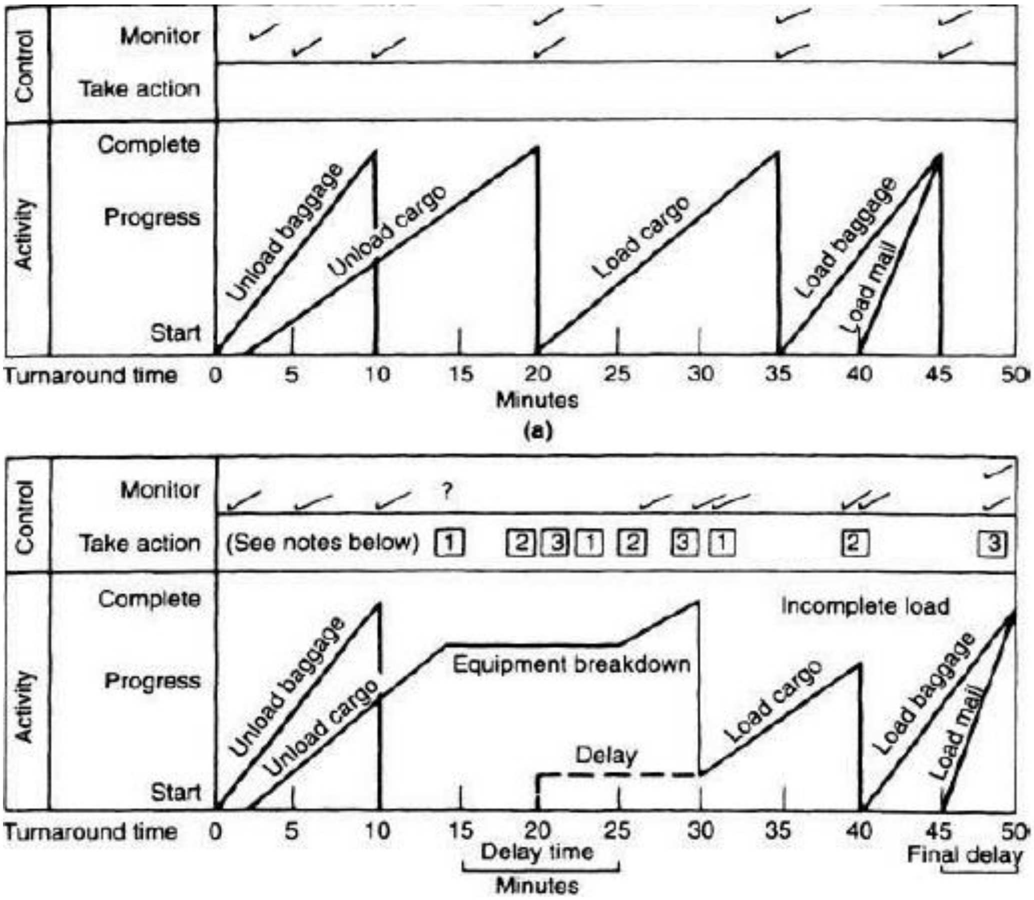

Fig 2.15 Effect of breakdown and delay on apron dispatch

Baggage handling

Baggage handling services include a number of activities involving the collection, sorting, and distribution of baggage. An efficient flow of baggage through the terminal is an important element in the passenger handling system. Departing passengers normally check their baggage at one of a number of sites including curbside check-in and at the ticket counter in the terminal building. The bags are then sent to a central sorting area, where they are sorted according to flights and sent to the appropriate gate to be loaded aboard the departing aircraft. Arriving baggage is unloaded from the aircraft and sent to the

central sorting area. Sorted bags are sent to a transferring flight, to the baggage claim areas, or to storage for later pickup (Fig. 2.16). At most airports, baggage handling is the responsibility of the individual air carriers.
Some airports operate a consolidated baggage service, either with airport personnel or on a contract basis.
One of the simplest and most widely applied methods to expedite baggage handling is curbside check-in. This separates baggage handling from other ticket counter and gate activities, thereby disencumbering those locations and allowing baggage to be consolidated and moved to aircraft more directly. Another method is replacement of the baggage claim carousel with loop conveyor belts that allow passengers greater access to their luggage without increasing the size of the claim area. Sorting baggage, moving it to and from the apron, and aircraft loading and unloading are time-critical and labor-intensive operations. Technologies to improve this process include high-speed conveyors to transport baggage between the terminal and the flight line, often used in conjunction with pallets or containers that can be put on and taken off aircraft with labor-saving equipment. Computerized baggage-sorting equipment, capable of distributing bags with machine-readable tags, has been installed at some airports.

Fig 2.16 *Baggage loading*

2.18 Security screening of checked baggage

As of January 1, 2003, all baggage checked in by passengers boarding commercial air carrier aircraft must be screened for explosives and other prohibited items upon check-in at the airport terminal. A detailed description of the facilities and processes that handle checked baggage screening may be found in Chap. 8 of this text.

Baggage claim

For passengers who checked baggage at the airport prior to departure, facilities for claiming their baggage must exist at the airport as well. Baggage claim facilities are typically located in an area conveniently positioned near facilities that accommodate ground transportation from the airport, including parking lots, shuttle vans, taxi cabs, and rental car counters. Baggage is typically presented to arriving passengers in the baggage claim area by use of a baggage claim carousel, configured in such a way as to provide sufficient carousel frontage to accommodate all passengers desiring access to their baggage, while minimizing the total amount of space required for the claim area (Fig. 2.17).

Fig. 2.17 Baggage claim facility

UNIT-III
PASSENGER TERMINAL AND CARGO OPERATIONS

3.1 Baggage Handling

Introduction

This chapter deals with baggage handling at airports from process, system, and organizational perspectives. The chapter itself is divided into the following topics:

- Context, history, and trends
- Baggage-handling processes
- Baggage-handling equipment, systems, and technology
- Process and system design drivers
- Organization
- Management and performance metrics

Context, History, and Trends

Baggage handling is an essential element of airport operations, but as with other utility functions, it is often remarked on only when it goes wrong. The effects of failure can range from a few passengers not receiving their bags when they arrive at their destination to the widespread disruption of airport operations, including flight cancellations, along with all that such events entail for airlines and passengers.

Historically, baggage appeared near the top of passengers' list of complaints, but this is no longer the case. An analysis of customer complaints over the period 2009-2012 shows that baggage-related issues accounted for less than 5 percent of all complaints. A total of 3.8 percent of complaints are attributable to third parties airlines and their handlers and only 0.3 percent are attributable to terminal operations-the baggage-handling systems themselves.

This improvement has been the result of an industry-wide appreciation of the costs associated with poor baggage-handling performance combined with investments in advanced, automated baggage systems around the world Even so, the cost to the airport and airlinecommunity (and hence the traveling public) is still large—the International Air Transport Association's (IATA's) director general, Giovanni Bisignani, remarked at The Wings Club in February 2009 that the global costs of mishandled bags were US$3.8 billion.

Even though baggage handling is usually carried out by an airline or its appointed handler, this distinction is often unclear to passengers. Thus, if they suffer problems or delays with baggage, passengers will assume that it is a failing of the airport, thereby risking its reputation. In practice, both airports and airlines have important roles to play and a collaborative approach to managing baggage handling leads to a better outcome for all parties.

Baggage-Handling Processes

A typical set of baggage processes in airports will have check-in, reclaim, and flight build facilities (also called *makeup)*, only hub airports will have any significant transfer-baggage facilities. Hub airports with multiple terminals also may have a significant inter terminal transfer process connecting passengers and their bags arriving at one terminal with their departure flights in a different terminal. Bags entering the system via a bag drop generally will be screened in the terminal of departure Once in the baggage system, optionally, they may be stored and then delivered to a flight build output. From there they are taken to the departing aircraft and loaded.

Terminating bags arriving at a terminal will be delivered to reclaim for collection by passengers. In some circumstances and jurisdictions, terminating bags are screened for illicit items.

Transfer bags arriving at a terminal will be input into the baggage system and routed to the terminal of departure. Once there, the process follows that for locally checked-in baggage. The major elements in this process are described in turn in the following sections.

Bag Drop

Off-airport check-in can be offered in a number of ways including in-town airline offices, check-in counters at downtown train stations, and services supporting check-in and bag drop at hotels. For example, in Hong Kong, most airlines have check-in counters at both Hong Kong and Kowloon Stations.

Airport Express passengers can check in and leave baggage at these facilities so that they are free to visit the city for the rest of day before leaving for the airport without having to carry their baggage around with them. Car-park and curbside check-ins are convenient ways to check in for a flight and to drop bags without having to take them through a crowded airport building.

They typically operate as follows:

• Pull up to a booth in a car park or the curb adjacent to the departure terminal, and present a photo ID along with a confirmation number, destination, flight number, or e-ticket number to an agent.

• Hand checked bags to the agent, collect the baggage receipt and boarding pass, and proceed straight to security.

The second wave is a bag drop where passengers can deposit hold baggage Often these bag drops are physically indistinguishable from a conventional check-in desk and are staffed in the same way it is simply that they are used purely for baggage acceptance.

There is growing interest in self-service bag drops, where passengers can deposit baggage without the need for a member of staff. Qantas is an early adopter of this approach for domestic traffic. In this arrangement, bag tags are printed and attached at a check-in kiosk [or permanent radiofrequency ID (RFID) tags are used for frequent flyers] so that tvtien the passenger reaches the bag drop, there is little more to do than put the bag onto the receiving conveyor. The average process time is in the range of 20 to 30 seconds per bag. This short process time (compared with 1 to 2 minutes or more for conventional check-in and bag drop), coupled with multiple bag drops, means that there are rarely queues of passengers waiting to deposit bags performed in waves one and two also can be performed, and they can deal with additional functions such as taking payment for excess baggage or rebooking.

Usually Bag drop will involve one or more of the following:

- Agents inspecting all baggage at check-in for size to capture all non-cabin-compatible items.
- Limits placed on the size of baggage at passenger screening, necessitating the prior check-in of items that cannot be carried in the cabin.
- Agents spotting passengers waiting in and around gate areas with unsuitable baggage so that the items can be tagged and loaded before boarding begins.

Usually gate bags do not need to be rescreened because they will have been checked along with the passenger through the processes needed to reach the gate.

Hold Baggage. Screening

Once bags have entered the baggage system, generally they will be screened using in-line x-ray machines [also known as *explosive- detection systems* (EDS)] to ensure that dangerous or prohibited items are not present. A typical European screening process is shown in Figure. Uncleared bags are examined by a level 1 hold-baggage screening (HBS) machine. These machines typically can process bags at rate of more than 1,000 per hour. If the machine and its image- processing algorithm are able to determine that there is no threat present, the machine will clear the bag. For perhaps 30 percent of bags, the image-processing algorithm will not be able to clear the bag confidently, so the image will be passed to a human operator for a level 2 decisions.

In most cases the bags then will be cleared, but typically 5 percent of all incoming bags will still be unresolved and will require a more detailed examination. These bags will be sent to a level 3 HBS machine, which uses computed tomography to give a three-dimensional image, allowing a more thorough examination by an operator. Level 3 machines typically have a throughput of 150 bags per hour. In the vast majority of cases, no threat will be present, and the operator will clear the bag. In a very small fraction of cases, the images taken at level 3 still will be inconclusive, and the bags will be sent to level 4, where a physical examination of the bag will be carried out.

The multilevel protocol adopted in the United States is as follows:
Level 1 screening is performed with EDS units. All bags that can physically fit in an EDS unit are directed to level 1 screening and scanned using an EDS. All bags that automatically alarm at level 1 are subject to level 2 screening.

During *level* 2 screening, Transportation Security Administration (TSA) personnel view alarm bag images captured during the level 1 EDS scan and clear any bags whose status can be resolved visually. All bags that cannot be resolved at level 2 and all bags that cannot be directed to level 1 because of size restrictions are sent to level 3 screening.

Level 3 screening is performed manually and involves opening the bag and the use of explosive-trace-detection (ETD) technology. Bags that do not pass level 3 screening (typically, a small percentage of total bags) are either resolved or disposed of by a local law enforcement officer.
The TSA has published guidelines and design standards for hold- baggage screening that provide an excellent introduction to the U.S. implementation of hold-baggage screening (TSA 2011).

Bag Storage

Originally, baggage-handling systems had no need to provide bag storage—bags for a flight were accepted at check-in only when the flight makeup positions were available for use, typically two to three hours before the scheduled departure time. Over time, the need for additional bag storage has increased. One factor is the growth in transfer traffic, which can mean that an inbound flight and its connecting bags arrive well before the planned flight makeup positions for the departing flight are open. Another reason is the desire to allow passengers to check in bags when they choose. And increasingly, bag stores can be used to manage and buffer the flow of bags to flight makeup positions, thereby enabling more efficient use of staff and infrastructure or even supporting robotic loading systems

The flight build process can be very simple, particularly for small, non-containerized aircraft where there are not many bags to be loaded. However, with larger, containerized aircraft and for airlines with more complex products, the flight build involves ensuring that bags are sorted and loaded by segregation.

Segregations might include some or all of the following:

- Premium terminating.
- Economy terminating.
- Crew bags.
- Short-connect transfers.
- Long-connect transfers.
- Inter-terminal transfers (by departure terminal).
- Onward transfers (by transfer destination).

Loading bags according to these types of segregation assists the speed and ease of handling at downstream stations, but at a price. The flight build operation becomes larger and more complex, and the filling efficiency of ULDs generally will be poorer because some ULDs will be only partially filled. Thus, build segregation policies depend on airline priorities and products, handling operations, and facilities at originating, terminating, and transfer airports.

Arrivals Reclaim.
The function of reclaim is to reunite passengers and their baggage. Since the arrival processes for passengers and baggage are very different, the reclaim hall functions as a buffer space—for passengers to wait for bags and for bags to wait for passengers.

The appearance profiles of passengers and bags at reclaim should be similar. This ensures that neither the reclaim device nor the reclaim hall becomes too busy with bags and passengers, respectively.

3.2Equipment, Systems, and Technologies

This section describes the equipment, systems, and technologies that are used to implement and support the processes outlined earlier.

Baggage-Handling-System Configurations

The design of the passenger terminal complex itself can radically affect the configuration of the outbound-baggage system. A number of design considerations are covered in IATA (2004).

Conventional centralized-pier finger airports, such as Chicago O'Hare, Schiphol Amsterdam, and Manchester International, operate on one or more central bag rooms in the main terminal area. These require elaborate sorting systems, but can be efficient in the use of personnel who are released when not needed in off-peak periods. Decentralized facilities, such as Frankfurt (Germany) and Dallas-Fort Worth, have a number of decentralized bag rooms that are closely associated with a few gates. The sorting requirements of these makeup areas are minimal, but it is more difficult to use staff efficiently in the decentralized situation, where there are substantial variations in workload between peak and off-peak periods. A third concept of baggage makeup area is the remote bag room. In an airport such as Atlanta, where three-quarters of the traffic is transfer, there is considerable cross-apron activity. Remote bag rooms provide for the complex sorting necessary without transporting all baggage back to the main terminal.

Check-in and Bag Drop

Traditional check-in and bag-drop desks can be arranged in a number of ways:

- Linear
- Island
- Flow-through

Both linear and island check-in have the disadvantage that the flow of passengers leaving the desks can conflict with queues of passengers waiting to reach the desks. Flow-through arrangements, however, avoid this difficulty but are feasible only where the terminal has the space to accommodate vertical movement of bags within the check-in floor plate.

Sorting

Once baggage has entered a system (other than the simplest), it has to be sorted. Destinations include screening equipment, manual encoding stations, and bag storage or flight makeup locations. There are several methods of sorting bags, the choice of which is governed by a combination of factors, including

- Space
- Cost
- Required capacity

For low-capacity applications, conveyor-based merges and diverts may be chosen. For somewhat higher capacities, vertical sorting and merge units may be employed because these can switch sufficiently quickly to allow adjacent bags to be sorted to two different locations with a throughput of over 1,000 bags per hour.

In cases where loose baggage is handled, every merge, divert, incline, and sorter in-feed or output has the potential for a bag to become snagged or trapped with the risk of damage to the system and/or bag. Careful design and tuning of the system become necessary to minimize this risk; otherwise, there will be frequent system stoppages and the associated cost of staff being needed to free jams.

Hold-Baggage Screening

As screening technology develops, new and better machines become available. The control authorities build this into their regulations to ensure the best-possible chance of detection of knownand potential threats.

To date in Europe, three standards of x-ray screening equipment have been identified:

- *Standard 1*—a single-view technology
- *Standard* 2—a multi-view technology
- *Standard 3*—a computed tomo-graphic technology

Bag Storage

Bag storage can take one of several forms. At its simplest is a manual store in which bags are grouped, by hand, by flight or departure time. This involves little more than space on the ground or racks to accommodate the bags. Automated stores vary in functionality. At one extreme,they simply automate the manual process—accumulating groups of bags in conveyor lanes by flight or build open time. Such a store does not readily lend itself to the retrieval of a single, particular bag—a whole lane of bags would have to be released to access just one specific bag.

More sophisticated stores allow random access to any particular bag. These stores usually depend on bags being carried in totes, which enable them to be transported and tracked effectively. One type of store involves setting up long conveyor loops on which the toted bags circulate slowly. As the bags pass outputs, they can be diverted so that they leave the store. Another type of store makes use of a warehouse crane and racking approach. Toted bags entering thestore are taken by crane and placed in a slot in a lane of racking. This, too, allows single bags to be retrieved and thereby offers the most flexible of storage systems.

Flight Build

The type and configuration of manual makeup devices are varied, including

- Chutes
- Carousels
- Laterals

Each offers a combination of advantages and drawbacks. Chutes can be arranged space efficiently, thereby ensuring a one-to-one mapping between chute and ULD and/or trailer. However, they suffer from poorer handling ergonomics than laterals. Carousels offer a flexible means of distributing bags to several makeup positions, but there can be concerns over the ergonomics of picking bags from a moving device. Laterals (Figure 7.15) can be set at an optimal height for operators and are compatible with modern manual handling aids.

New ways of handling flight build are being implemented, and these require different makeup devices. Of particular note are fully automated, robot-based build cells and semi-automated batch build devices.

A build cell employs a robotic arm fitted with a specialized handling tool to receive a bag from the baggage-handling system and, using a machine vision system, then will place the bag into a trailer or ULD. The work rate achieved by such systems is typically three to four bags per minute—not necessarily faster than a human operator, but it is sustainable indefinitely and relieves handlers of the physical load. A build cell cannot operate unsupervised

Reclaim

The most common baggage reclaim device is a carousel, of which there are several variants. The two principal choices are

- Flatbed or inclined
- Direct or indirect infeed(s)

3.3 Process and System Design Drivers

Appearance Profiles

The appearance profile of bags at an airport is an important factor that influences the need for facilities to be open and available (e.g., check-in and transfer inputs), as well as the need for bag storage. The appearance profiles shown in Figure 7.19 are taken from a European hub airport for the major types of destinations. At first glance, the results suggest that the longer the journey, the earlier the bags will appear.

Bags per Passenger

Bag-per-passenger ratios are a key component in the design basis for baggage facilities, and they vary considerably by type of passenger

Parameter	Value
Check-in process	1-2 minutes per person
Bag drop process	0.5-2 minutes per bag (prelabeled to full-service)
ULD build rate	3-4 bags per minute
ULD break rate	8-12 bags per minute
In-line baggage-screening rate	15-20 bags per minute per machine (standards 1 and 2)
Aircraft ULD un/loading process	3 minutes per pair of AKE ULDs (one hold)
Reclaim input rate	20 bags per minute

TABLE **3.1** Processing Times

Fig.3.1 Airline-designated checkin area

Fig.3.2 Computer-assigned CUTE passenger checkin desks

3.4 Processing Times

The number of facilities required to service a given demand depends on the processing times associated with that particular facility. Table 3.1 lists a number of important parameters.

Arrivals Delivery Performance

The speed of delivery of bags from an inbound aircraft to either a reclaim device (for terminating bags) or the input of the baggage handling system (for transfer bags) is the key measure of handler performance. Flight historically, this has been measured by first and last bag delivery times—for example, first bag on reclaim within 15 minutes and last bag on reclaim within 25 minutes of aircraft arrival on chocks. Such measures have the benefit of simplicity and can be used to
encourage good handler performance, but three trends mean that more refined targets are becoming necessary at some airports:

- An increase in the number of very large aircraft
- A desire to reduce minimum connection times
- An increase in the size of airports and hence distances between facilities

The implications of these trends are described in turn. First, a performance standard based on delivering, say, 250 bags from a medium sized aircraft becomes challenging to achieve for a very large aircraft with 500 or more bags. Second, the need to achieve reliable, short- transfer connection times (especially from very large aircraft with many transfer bags) means that a tighter performance standard needs to be applied to the time-critical transfer bags while allowing more time for non-time-critical bags. Third, large airports (without distributed arrival baggage systems) inevitably lead to longer driving times from some stands to reclaims than from others, making a "one size fits all" standard inappropriate.

In order to deal with the growth in size and scale, different priorities can be assigned to the four main categories of inbound bags:

- Premium terminating (e.g., first class, business class, frequent- flyer cardholders)
- Economy terminating
- Short-connect transfers (with scheduled connection times of less than about 2 hours)
- Long-connect transfers (with scheduled connection times of more than about 2 hours)

Logic dictates that premium bags should be delivered before economy bags and that short-connect bags should be delivered before long-connect bags. The only remaining choice is whether to prioritize premium bags over short-connect bags or vice versa. Long-connect bags should be given the lowest priority in any case. Of course, the ability to fine-tune the delivery of these different categories depends on the appropriate segregation and loading of the inbound aircraft.

For reclaim, it is desirable to set targets for the delivery of bags *relative to the arrival of passengers* in the reclaim hall. For example, the aim might be to deliver all premium bags before the first passengers reach the reclaim hall so that no premium passengers have to wait for their bags. A maximum-waiting-time target might be set for economy passengers. In practice, this can be hard to measure and control. While processes and systems can be put in place to log when a bag is delivered to the reclaim device, it is much harder to monitor the arrival times at reclaim of specific passengers.

3.5 COMPONENTS OF AIRPORT:

Therefore, the **main components of airport are:**

1. Landing Area of Airport

It is the airport components used for landing and takeoff operations of an aircraft. Landing Area includes ***Runways*** and ***taxiways***.

Fig.3.3 Elevating passenger air bridge

Fig 3.4.**Three-loading-bridge configuration serving an A380**

2. Terminal Area

The transition of passengers and goods from ground to air takes place in the terminal area. Various methods are used to accommodate and transfer the public and its goods arriving either by ground or by air. The degree of development in the terminal area depends upon volume of airport, operations, type of air traffic using airport, number of passengers and the airport employees to be served and the manner in which they are served and accommodated. Terminal area consists of the following parts ***Terminal building***, ***Apron***, ***Automobile Parking Area***, ***Hangers***.

Landing area is the component of airport used for landing and takeoff operations of an aircraft. Landing area includes

Fig. 3.5. Mobile apron engine air-start vehicle

Fig.3.6 Aircraft tow tractor

Fig.3.7 Mobile apron fuel tanker (browser).

Fig.3.8 Mobile aircraft fuel dispenser for fueling from apron hydrant system.

1. Runways

It is the most important part of an airport in the form of paved, long and narrow rectangular strip which actually used for landing and takeoff operations. It has turfed (grassy) shoulders on both sides. The width of runway and area of shoulders is called the landing strip. The runway is located in the center of landing strip. The length of landing strip is somewhat larger than the runway strip in order to accommodate the stop way to stop the aircraft in case of abandoned takeoff.

The length and width of runway should be sufficient to accommodate the aircraft which is likely to be served by it. The length of runway should be sufficient to accelerate the aircraft to the point of takeoff and should be enough such that the aircraft clearing the threshold of runway by 15m should be brought to stop with in the 60% of available runway length. The length of runway depends on various meteorological and topographical conditions. Transverse gradients should not be less than 0.5% but should always be greater than 0.5%.

2. Taxiways

Taxiway is the paved way rigid or flexible which connects runway with loading apron or service and maintenance hangers or with another runway. They are used for the movement of aircraft on the airfields for various purposes such as exit or landing, exit for takeoff etc. The speed of aircraft on taxiway is less than that during taking off or landing speed.

The taxiway should be laid on such a manner to provide the shortest possible path and to prevent the interference of landed aircraft taxing towards loading apron and the taxiing aircraft running towards the runway. The intersection of runway and taxiway should be given proper attention because during turning operation, this part comes under intense loading. If it is weaker then the aero plane may fell down from taxiway. Its longitudinal grade should not be greater than 3% while it s transverse gradient should not be less than 0.5%. It is also provided with a shoulder of 7.5m width paved with bituminous surfacing. The taxiway should be visible from a distance of 300m to a pilot at 3m height from the ground.

3.6 Passenger Terminal Operations

Functions of the Passenger Terminal

Analysis of the operation of an airport passenger terminal leads to the conclusion that three principal transportation functions are carried out within the terminal area (Ashford et al. 2011):

1. *The processing of passengers and baggage.* This includes ticketing, check-in and baggage drop, baggage retrieval, governmental checks, and security arrangements.

2. *Provision for the requirement of a change of movement type.* Facilities are necessarily designed to accept departing passengers, who have random arrival patterns from various modes of transportation and from various points within the airport's catchment area at varying times, and aggregate them into

planeloads. On the aircraft arrivals side, the process is reversed. This function necessitates a holding function, which is much more significant than for all other transport modes.

3. *Facilitating a change of mode.* This basic function of the terminal requires the adequate design and smooth operation of terminal facilities of two mode types. On the airside, the aircraft must be accommodated, and the interface must be operated in a manner that relates to the requirements of the air vehicle. Equally important is the need to accommodate the passenger requirements for the landside mode, which is used to access the airport.

An intimation of the complexity of the problem can be grasped from an examination of Figure 8.1, which is admittedly a simplification of the flow process for passengers and baggage through a typical domestic-international airport passenger terminal. When examining a chart of this nature, it must be remembered that the representation can only be in generalized terms and that the complexities of operation are introduced by the fact that flows on theairside are discrete and those on the landside are continuous.

The substantial growth rate of air transportation since World War II has meant that many airports around the world are now large operations. Unlike the pre-1940 period, when air transportation was a fringe activity on the economy, the air mode is now a well-established economic entity. The result on passenger terminals has been dramatic (Hart 1985). More than a score of large international airport terminals are handling more than 30 million passengers per year, and the number continues to grow. Operations of this scale are necessarily complex.

Terminal Functions

Transportation planners use the term *high-activity centers* to describe facilities such as airport terminals that have a high throughput of users. In the peak hour, the largest passenger airports process well in excess of 10,000 passengers. With the increased security measures since 2001, departing international passengers are likely to spend *IV*2 to 2 hours in the terminal facility, and arriving international passengers spend at least 30 minutes.

During the period that they spend in the terminal, passengers are necessarily engaged in a number of processing activities and are likely to use a number of subsidiary facilities put in the airport for their comfort and convenience, as well as for the airport's profit.

Before discussing in some detail these individual activities, it is worth classifying the terminal activities into five principal component groups:

- Direct passenger services.
- Airline-related passenger services.
- Governmental activities.
- Non-passenger-related airport authority functions.
- Airline functions.

Either directly or indirectly, these functions, where conducted in the passenger terminal area, will involve some responsibility on the part of the terminal manager. Figure shows the typical organization of these responsibilities for the terminal operation at a major airport.

Passenger Terminal Operations 221The individual terminal functions are discussed in more detail.
Philosophies of Terminal Management
Although the basic operational procedures of airports as they relate to safety are generally similar throughout the world, the manner in which those procedures are operated and the organization used to affect them can differ quite radically.

Perhaps nowhere in the airport do the operational philosophies differ as much as in the terminal area.

The two extreme positions may be designated as
- Airport-dominant
- Airline-dominant

Where terminal operations are airport-dominant, the airport authority itself provides the staff to run terminal services. Apron, baggage, and passenger handling are either entirely or largely carried out by airport-authority staff. Services and concessions within the terminal are also mainly authority operated. Airport-dominant operations are sometimes called the *European model,* although similar arrangements are found throughout the world. Frankfurt is perhaps the best example of this form of operation, which involves high airport- authority staffing levels and high authority equipment costs with concomitant savings to airlines.

Most major airports around the world work on a mixed model, where the airport authority takes care of some terminal operations, and airlines and concessionaires operate other facilities. In some airports, competitive facility operation is encouraged to maintain the high service standards usually generated by competition. In the European Union, European Commission (EC) directives are forcing airports to introduce competition at airports where operation previously has been by a single organization. This trend away from single authority operation has been aided by the increasing trend toward total airport privatization, either by outright transfer of ownership outside the public sector or by the granting of long-term concessions for the operation of entire airports.

Competitive handling operations are also less vulnerable to a complete shutdown by industrial action. The final choice of operational procedure will depend on a number of factors, including:

- Philosophy of the airport authority and its governing body
- Local industrial relations
- International and national regulations
- Financial constraints
- Availability of local labor and skills

Direct Passenger Services:

Terminal operations that are provided for the convenience of air travelers and are not directly related to the operations of the airlines are normally designated as direct passenger services. It is convenient to further divide this category into commercial and noncommercial services. There is no hard-and-fast division between these two subcategories, but noncommercial activities are usually seen as being entirely necessary services that are provided either free of charge or at some nominal cost. Commercial activities, on the other hand, are potentially profitable operations that are either peripheral to the transportation function of the airport (e.g., duty-free shops) or avoidable and subject to the traveler's choice (e.g., car parking and car rental).
Typically, at a large passenger terminal, the following noncommercial activities will be provided,

usually by the airport authority:

- Porter age
- Flight and general airport information
- Baggage trolleys
- Left-luggage lockers and left-luggage rooms[2]
- Directional signs
- Seating
- Toilets, nurseries, and changing rooms
- Rest rooms
- Post office and telephone areas
- Services for people with restricted mobility and special passengers[1]

Depending on the operating philosophy of the airport, commercial facilities will be operated either directly by the authority itself or leased on a concessionary basis to specialist operators. Typically, at a large airport, the following commercial activities can be expected to play and important part in the operation of the passenger terminal:

- Car parking
- Restaurants, cafes, and food bars
- Duty-free and tax-free shops
- Other shops (e.g., book shops, tourist shops, boutiques, etc.)
- Car rental
- Internet service
- Insurance
- Banks and exchange services
- Hairdressers, dry cleaners, and valet services
- Hotel reservations
- Amusement machines, lotteries
- Advertising

Business-center facilities large passenger terminals are generators of large commercial profits. If commercial exploitation of the airport is decided on, a number of operational policy decisions must be made. First, a decision must be made on the mode of operation. Five different modes are common.

Fig. 3.9 Catering truck in loading position

Fig 3.10 Fixed ground cooling unit attached to an air bridge

- A department of the airport authority directly
- A specially formed, fully owned commercial subsidiary of the airport authority

- A commercial subsidiary formed by the airport authority and the airlines
- A commercial subsidiary formed by the airport authority and a specialist commercial company
- An independent commercial enterprise

Other methods of control that have been used successfully include

1. *Length of lease.* Medium-term leases of 5 to 10 years have several advantages. They permit the concessionaire to run an established operation with medium-term profits. Successful operators usually are able to renegotiate for renewed concessionary rights. Unsuccessful operators can be removed before long-term financial damage accrues to the airport.

2. *Exclusive rights.* In return for exclusive rights on the airport, the authority can demand contractual arrangements that protect the airport's financial and performance interests. There is a significant recent move away from granting exclusive rights in shopping concessions in order to encourage competitive pricing.

3. *Quality of service.* Many airports require contracts that restrict the concessionaire's methods of operation. These constraints include authority control over the range of goods to be stocked, profit margins and prices, and staffing levels, as well as detailed operational controls on such items as advertising, decor, and display methods.

Where the airport is privately owned, there are no limits on how the concessionary contracts can be drawn up. If the operator of the airport is itself a concession, the government may impose limits on how sub concessions are to be arranged.

Advertising is an area of financial return that has not been fully explored by many airports. The advertising panel shown in figure is an example of a very satisfactory modern display that adds to the decor of the terminal without clutter while paying a handsome return to the authority from a little financial outlay. Care must be taken in selecting advertising so that the displays do not interfere with passenger flow or obstruct necessary informational signs. Significantly, there are airports that ban internal advertising on aesthetic grounds, but these are growing fewer in number.Facilities (IATA 2004).

3.7 Airline-Related Operational Functions

Flight Dispatch

A major preoccupation for airline management in relation to airport terminal operations is the achievement of on-time departures. Many of the activities associated with this, such as the refueling and cleaningof aircraft, together with the loading of food supplies, are carried out on the ramp and are familiar to most airport staff. There is, however, a less familiar procedure that covers all the necessary technical planning without which a flight could not depart.

The main activities associated with this procedure of flight dispatch are

- Flight planning
- Aircraft weight and balance
- Flight-crew briefing
- Flight watch

In the United States, this is a long-established procedure, and the work is carried out by aircraft dispatchers who work in close cooperation with the aircraft captain. Flowever, in the case of large airlines, the flight-planning process is carried out more often as a central function at the airline's home base (for American Airlines, this is Dallas). Although aircraft dispatchers are used by many international airlines, there is also the designation of flight operations officer for staff members who carry out this work.

The airline departments at airports concerned with flight dispatch will need access to airport operations departments, air traffic services, meteorological services, and communications facilities, including email, internet, teleprinters, telephones, and radios. Depending on the extent of their activities, many airline operations offices also will use a variety of computer facilities, although these latter may not necessarily be in-house systems.

Flight Planning

The primary purpose of flight planning is to determine how long an individual flight will take and how much fuel will be required. For long-range flights, there will be a variety of options in terms of altitudes, tracks, and aircraft power settings and speeds. Variations in weather, wind, and temperature also will have to be taken into account. Of course, computerized flight-planning tools are used by major airlines to perform these optimizations.
Such tools examine feasible options so that a decision can be taken as to the most appropriate of the several alternatives. The evaluation might include an indication of comparative costs: A slower flight might prove desirable from a cost point of view. The analysis would include several altitude options. This often proves useful if, owing to the density of traffic, air traffic control (ATC) has to impose a last-minute altitude change.

For short-range flights, there are generally very few options, and in areas of very dense traffic, routings for all practical purposes are predetermined by the structure of the airways. In such cases, such as, for example, in Europe, the flight plans usually will be standardized to the extent that relevant extracts can be placed on permanent file with ATC. These are referred to in Great Britain.

As *stored flight plans* and are automatically printed out from ATC computer files in advance of flight departures. The airline flight plans, the operational or company flight plans, give a great deal of information, including the en-route consumption of fuel. Such details are not the concern of ATC, which requires altitudes and times in relation to the ATC system checkpoints, together with certain safety details (e.g., number of persons on board the aircraft and the detail of the instrument-flying aids and safety equipment carried by the aircraft). The international format for the ATC flight plan is shown in Figure 3.9.

3.8 Aircraft Weight and Balance

The *dry operating weight* of an aircraft is taken as the starting point for weight calculations. To this is added the anticipated payload, which consists of

- Cargo load
- Passengers
- Baggage

This provides the *zero-fuel weight.* The total fuel load is added, less an allowance for fuel used in taxiing before takeoff, to calculate the *takeoff weight.* The fuel that is expected to be consumed during the flight is deducted from the *takeoff weight* to calculate the *landing weight.*

It should be noted that these calculations may be in either pounds, which is the case in the United States, or in kilograms. However, before any actual load calculations can be carried out, account must be taken of the physical weight limitations, the design limits, of the aircraft structure in the various operation phases.

Takeoff

There is a *maximum takeoff weight* (i.e., at brake release) that the available power can lift off the runway and sustain in a safe climb. The value is established by the manufacturer in terms of ideal conditions of temperature, pressure, runway height, and surface conditions. Along with these values, the manufacturer will provide performance details for variations in any of these conditions.

In Flight

There are limits on the flexibility of the wings of each aircraft design. These are imposed by the upward-bending loads that the wing roots can sustain without breaking. The greatest load would be imposed if , there were no fuel remaining in the wings (fuel cells), which is why the *zero-fuel weight* is taken as a limitation on fuselage load.

Landing

Depending on the shock-absorbing capabilities of the aircraft undercarriage, there is a *maximum landing weight* that it can support on landing without collapsing. Thus the three design-limiting weights are maximum takeoff weight, maximum zero-fuel weight, and maximum landing weight. Typical examples of these values for a Boeing 747-300 are

- Maximum takeoff weight 883,000 pounds (377,850 kg)
- Maximum zero-fuel weight 535,000 pounds (242,630 kg)
- Maximum landing weight 574,000 pounds (260,320 kg)

The completed flight plan will provide two fuel figures:

Takeoff fuel. This is the total amount of fuel onboard for a particular flight. This does not include taxiing fuel but will include required fuel reserves for flight to an alternative destination or for holding or delay before landing.

Trip fuel. This is the fuel required for the trip itself, that is, between the takeoff and the point of first intended landing (it is also sometimes referred to as *burnojf).*

In order to arrive at the maximum permissible takeoff weight, we compare three possible takeoff weights:

- Takeoff weight' = maximum takeoff weight
- Takeoff weight" = aero-fuel weight + takeoff fuel
- Takeoff weight"' = landing weight + trip fuel

The lowest of these three values is the maximum allowed takeoff weight, and this value minus the operating weight will give the allowed traffic load. These and other values are used in relation to aircraft weight calculations and load, and they also appear on the load sheet, for which there is a format agreed on by the IATA. Together with the values for takeoff fuel and trip fuel, the following operational figures are included in a load-sheet calculation:

- *Dry operating weight.* The weight of the basic aircraft, fully equipped, together with crew and their baggage, pantry/ commissary supplies, and flight spares, but not including fuel and payload
- *Operating weight.* The sum of dry operating weight and takeoff fuel
- *Takeoff weight.* The operating weight plus payload (traffic load)
- *Total traffic load.* The sum of the weights of the various types of load, that is, passengers, baggage, cargo, and mail, as well as the weight of any unit-load devices (ULDs, containers) not included in the dry operating weight

All these various weights appear on the load sheet together with a breakdown of the weight distribution.

3.9 Balance/Trim

Having ensured that the aircraft load is within the permitted weight limitations, it is then necessary to distribute the load in such a way that the center of gravity is within the prescribed limits. This is calculated by means of a trim sheet, which might be a separate form or part of a combined load and trim sheet. On the trim diagram, each of the aircraft's compartments is given a scale graduated either in units of weight, for example, 1,100 pounds (500 kg), or blocks of passengers (e.g., five passengers). Starting from the dry-operating-index scale, the effect of weight in each compartment then is indicated by moving the required number of units along the scale in the direction of the arrow and dropping a line down from that point to the next scale, where the process is repeated, ending up with a line projecting down into the center-of-gravity (CG) envelope, where its value is noted as a percentage of the wing mean aerodynamic chord (MAC).

The outer limits of the envelope are clearly indicated by the shaded areas. Certain sections of the load-sheet side of the form are also shaded to indicate data that should be included in a load message to be transmitted to the aircraft destination(s). These functions are now almost universally computerized.

Loading

The distribution of the load into various compartments must be detailed for the information of ramp loading staff, and this is achieved by the issue of loading instructions, usually in the form of computer-drawn diagrams. In Figure, the details are given of the various container positions. Where containers are not used, it will be necessary at this stage to take into account limitations in respect to dimensions, vis-a-vis the measurements of the hatch openings and also maximum floor loadings, and the loading instructions will be drawn up accordingly.

All matters relating to the load carried on an aircraft and the position of the CG have such a direct influence on flight safety that the documents used are of considerable legal significance, reflecting as they do the regulations of each country. For this reason, they have to be signed by the airline staff responsible for these various aspects.

Flight-Crew Briefing

The purpose is to present to flight crew appropriate advice and information to assist them in the safe conduct of a flight. The information will include a flight plan and load details together with information regarding en-route and destination weather and notices regarding any unserviceability's of navigation or landing aids.

Passenger Information Systems

Passengers move through airport terminals under their own power. They are not physically transported in a passive manner, as is freight, although in larger terminals mechanical means are used to aid in movement through the facility. This, of course, does not refer to people with restricted mobility, who need special ramps and other necessities, which are beyond the scope of this book. Equally important, a large number of passengers reach airports in their own personal vehicles. There is therefore a need to ensure that the passenger has sufficient information both in the access phase of the journey and in passing through the terminal to reach the correct aircraft gate at the right time with a minimum of difficulty and uncertainty..

3.10 VIP lounge facilities. (Source: Bahrain International Airport)

Additionally, the passenger requires information on the location of many facilities within the terminal, such as telephones, toilets, cafeterias, and duty-free shops. Information therefore is usually functionally classified into either directional- guidance or flight-information categories. Directional guidance com- mences some distance from the airport and normally involves cooperation with some local governmental authority to ensure that suitable road signage is incorporated into the road system on all appropriate airport access roads.

Often such signs include an aircraft symbol to help the driver to identify directions rapidly. Nearer the airport, terminal-approach road signs will guide the passenger to the appropriate part of the terminal. It is essential that the driver be given large, clear signs in positions that permit safe vehicular maneuvering on the approach-road system. The driver must obtain information on the route to be taken with respect to such divisions as arrivals/departures and domestic/international flights and often to airline-specific locations.

In multi-terminal airports, there will be signage to each individual terminal, either by terminal designation or by airline groups. Within the terminal, departing passenger flows are guided principally by directional- guidance signs, which indicate check-in, governmental controls, departure lounges, gate positions, and so on. Other terminal facilities that must be identified are concessionary areas and public service facilities such as telephones, toilets, and restaurants.

Information signs in terminal

It is essential that the signage is carefully designed. The International Civil Aviation Organization (ICAO) has a set of recommended picto- grams for signage inside terminals. Many airports have adopted their own signage convention. In some cases, the signage used falls short of acceptable standards. Sufficient signage must be given to enable the passenger to find the facility or the direction being sought; equally, there cannot be such a proliferation of signs that there is confusion. It is essential that the signage configuration be designed to conform to available internal building heights, which itself must be set recognizing that overhead signage is essential. Once in the terminal, passengers receive information concerning the status and location of departing flights by the departure side of the flight information system. Historically, this information has been displayed on mechanical, electromechanical, or electronic departure flight information boards.However, these largely have been supplanted by cheaper visual display units (VDUs), which can be located economically at a number of points throughout the terminal.

3.11 Airport terminals

Objectives

The objectives of this section are to educate the reader with information to:

- Understand the development of airport terminals from the early days of commercial aviation to present-day terminal design concepts.
- Identify the facilities within an airport terminal that facilitate the transfer of passengers and baggage to and from aircraft.
- Describe the essential and ancillary processing facilities, including terminal concessions, located within airport terminals.
- Be familiar with the various modes of transportation that comprise airport ground access systems.
- Describe various technologies that are being implemented to improve ground access to airports.

Introduction

The airport terminal area, comprised of passenger and cargo terminal buildings, aircraft parking, loading, unloading, and service areas such as passenger service facilities, automobile parking, and public transit stations, is a vital component to the airport system. The primary goal of an airport is to provide passengers and cargo access to air transportation, and thus the terminal area achieves the goal of the airport by providing the vital link between the airside of the airport and the landside. The terminal area provides the facilities, procedures, and processes to efficiently move crew, passengers, and cargo onto, and off of, commercial and general aviation aircraft.

Unit terminal concepts

These first terminals were the earliest **centralized facilities,** centralized meaning that all passenger processing facilities at the airport are housed in one building. These first centralized facilities became known as the earliest **simple unit terminals,** because they contained all required passenger processing facilities for a given air carrier in a single-unit building. In addition to passenger processing facilities, the airport’s administrative offices, and even air traffic control facilities, were located within the unit terminal building (Fig. 3.11).

Combined unit terminal

As multiple airlines began to serve single communities, airport terminals expanded in two ways. In smaller communities, two or more airlines would share a common building, slightly larger than a simple unit terminal, but have separate passenger and baggage processing facilities. This configuration became known as the combined unit terminal. In larger metropolitan areas, separate buildings were constructed for each airline, each building behaving as its own unit terminal. This terminal area configuration became known as the multiple-unit terminal concept (Fig. 3.12). Even though the multiple-unit terminal area consisted of separate facilities for each airline, it is still considered an individual *centralized* facility because all passenger and cargo processing required for any given passenger or piece of cargo to board any given flight still exists in one facility.

Fig. 3.11 *Allegheny County, Pennsylvania, historical unit terminal*

Fig 3.12 Combined unit terminal

Linear terminal concepts

As airports expanded to meet the growing needs of the public, as well as the growing wingspans of aircraft, simple-unit terminals expanded outward in a rectangular or *linear* manner, with the goal of maintaining short distances between the vehicle curb and aircraft parking that existed with unit terminals. Within linear terminals, ticket counters serving individual airlines were introduced and loading bridges were deployed at aircraft gates to allow passengers to board aircraft without having to be outside on the apron, thereby improving convenience and safety for passengers. In some instances airports were extended in a **curvilinear** fashion, allowing even more aircraft to park "nose-in" to the terminal building while maintaining short walking distances from the airport entrance to the aircraft gate (Fig. 3.13).

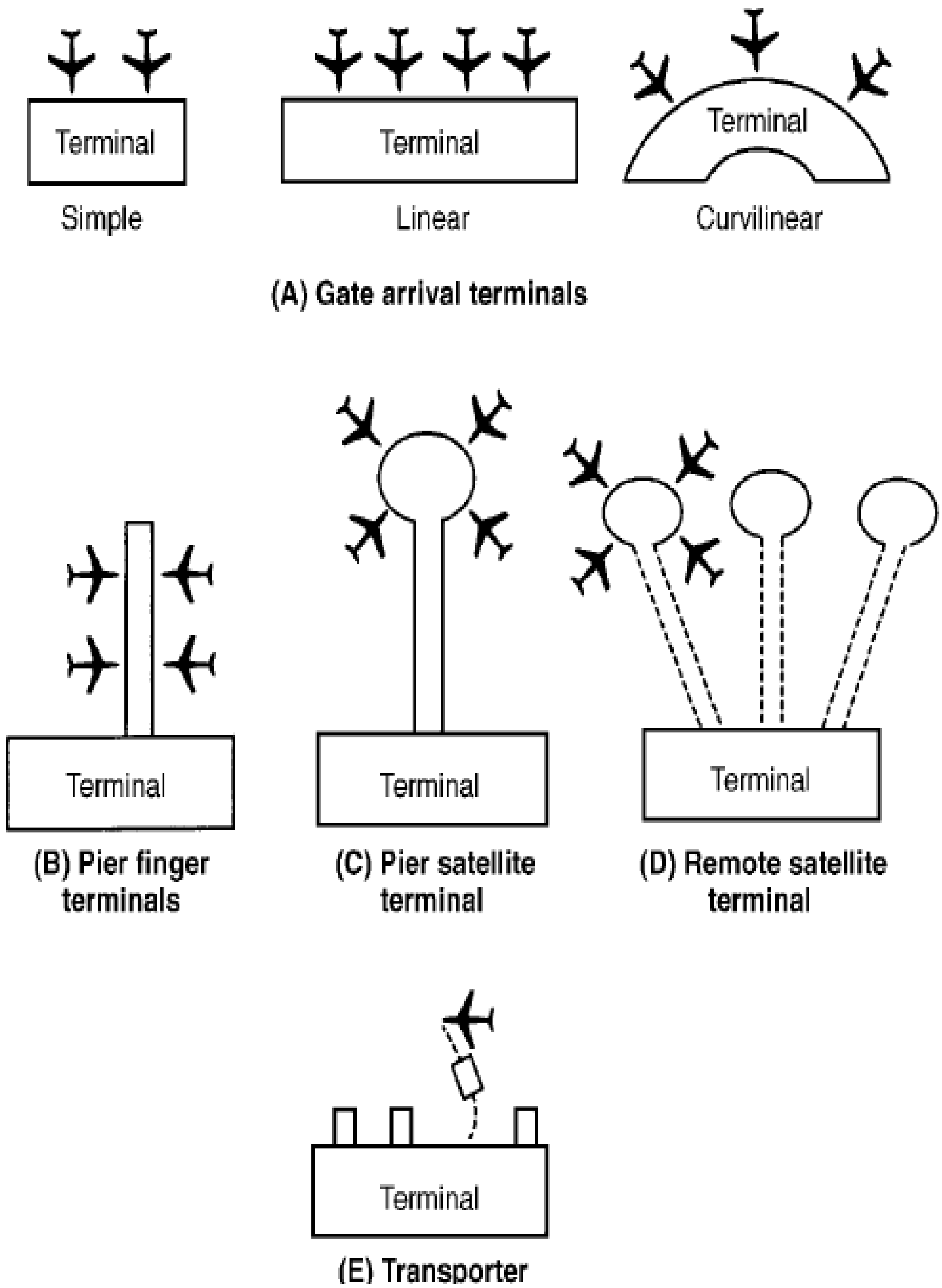

Fig 3.13 Linear concept terminals

Fig. 3.14 Curvilinear terminal concept

Pier finger terminals

The pier finger terminal concept evolved in the 1950s when gate concourses were added to simple unit terminal buildings. Concourses, known as piers or fingers, offered the opportunity to maximize the number of aircraft parking spaces with less infrastructure. Aircraft parking was assigned to both sides of a pier extending from the original unit terminal structure. The pier finger terminal is the first of what are known as decentralized facilities, with some of the required processing performed in common-use main terminal areas, and other processes performed in and around individual concourses. Many airports today have pier finger terminals in use. Since the earliest pier finger designs, very sophisticated and often convoluted forms of the concept have been developed with the addition of hold rooms at gates, loading bridges, and vertical separation of enplaning and deplaning passengers in the main-unit terminal area. As pier finger terminals expanded, concourse lengths at many terminal buildings became excessive, averaging 400 feet or more from the main terminal to the concourse end. In addition, as terminals expanded by adding additional piers, distances between gates and other facilities became not only excessive in distance, but also confusing in direction. Moreover, often the main-unit terminal facility and corridors connecting the individual fingers were not expanded along with the construction of additional concourses, leading to passenger crowding in these areas (Fig. 3.15).

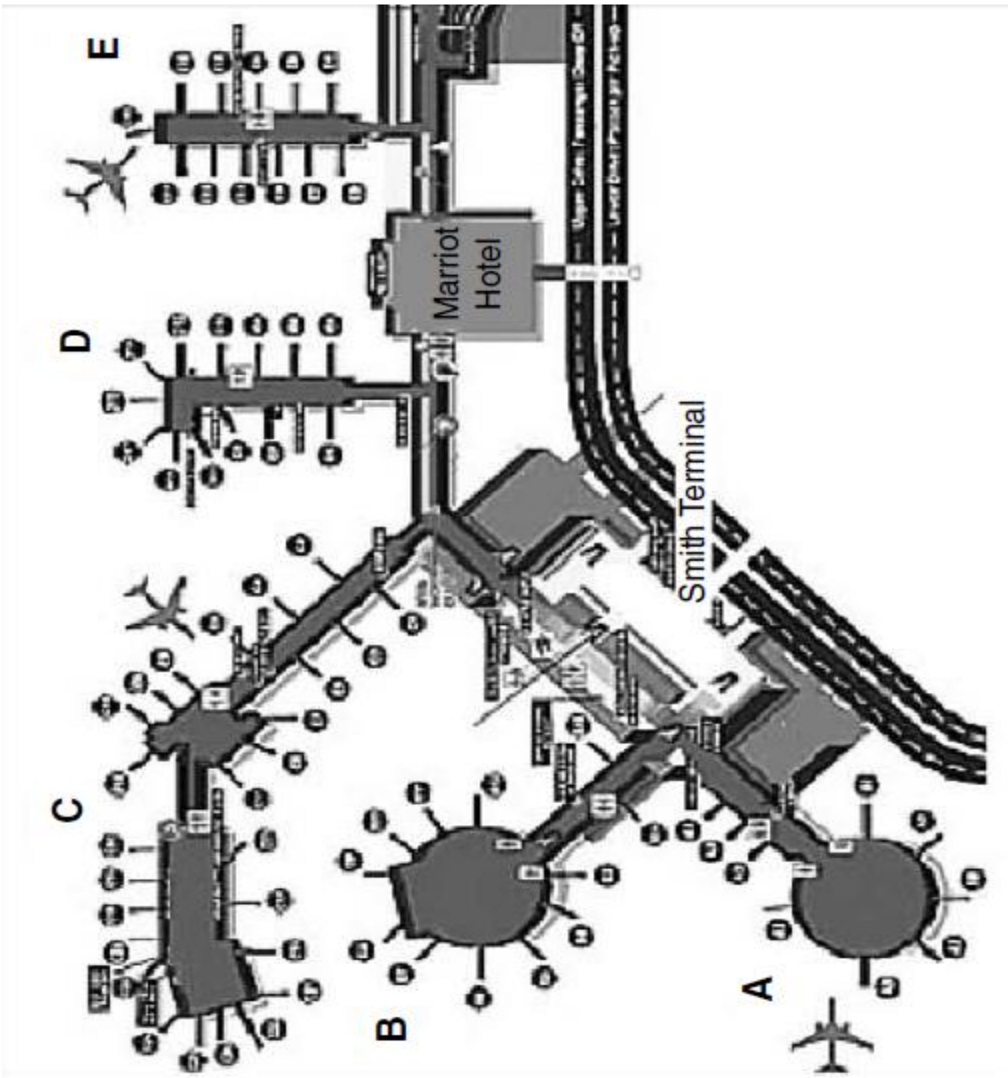

Fig. 3.15 Pier finger terminals

3.12 The mobile lounge or transporter concept

In 1962 the opening of Dulles International Airport west of Washington, D.C., designed as the first airport specifically for the new jet aircraft of the day, introduced the **mobile lounge** or *transporter concept* of airport terminals. Sometimes known also as the *remote aircraft parking concept*, the Washington Dulles terminal area attempted to maximize the number of aircraft that may be parked and maximize the number of passengers that may be processed, with minimal concourse infrastructure. In this concept, aircraft are parked at remote parking locations away from the main-unit terminal building. To travel between aircraft and the terminal building, passengers would board transporters, known as mobile lounges, that would roam the airfield among ground vehicles and taxiing aircraft (Fig. 3.16).

Fig.3.16 Washington Dulles International Airport terminal

Fig 3.17 Mobile lounge attached to aircraft at Washington's Dulles

3.13 Components of the airport terminal

The airport terminal area is in the unique position of accommodating the needs of both aircraft and the passengers that board them. As such, the component systems of the airport terminal area may be thought of as falling into two primary categories: the **apron and gate system,** which is planned and managed according to the characteristics of aircraft, and the *passenger and baggage handling systems,* which are planned and managed to accommodate the needs of passengers and their baggage in their transition to or from the aircraft.

The apron and gate system

The apron and gates are the locations at which aircraft park to allow the loading and unloading of passengers and cargo, as well as for aircraft servicing and preflight preparation prior to entering the airfield and airspace. The size of aircraft, particularly their lengths and wingspans, is perhaps the single greatest determinant of the area required for individual gates and apron parking spaces. In fact, the grand size of airport terminals is a direct result of large numbers of gates designed to accommodate aircraft of wingspans reaching 200 feet in length. The size of any given aircraft parking area is also determined by the orientation in which the aircraft will park, known as the *aircraft parking type.* Aircraft may be positioned at various angles with respect to the terminal building, may be attached to loading bridges or *Jetways,* or may be freestanding and adjoined with *air stairs* for passenger boarding and deplaning. Some aircraft parking types require aircraft to be maneuvered either in or out of their parking spaces by the use of *aircraft tugs,* whereas other parking types allow the movement of aircraft in and out under their own power. The five major **aircraft parking** types are *nose-in parking, angled nose-in, angled nose-out, parallel parking,* and *remote parking* (Fig. 3.18).

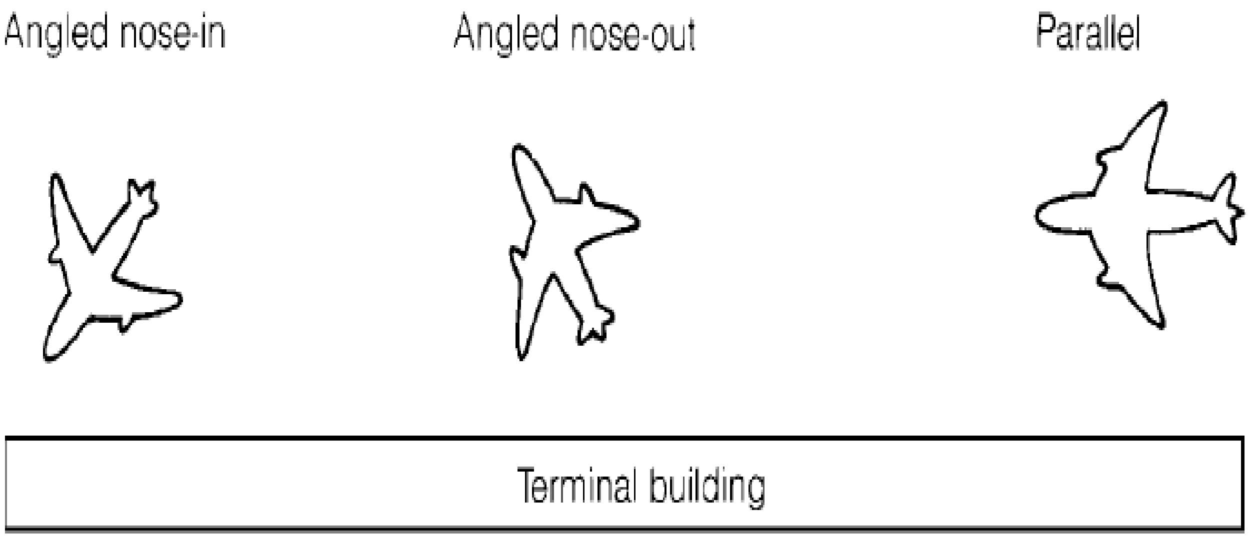

Fig 3.18 *Aircraft parking positions.*

Parallel parking

Parallel parking is said to be the easiest to achieve from an aircraft maneuvering standpoint, although each space tends to require the largest amount of physical space for a given size of aircraft. In this configuration, both front and aft doors of the aircraft on a given side may be used for passenger boarding by loading bridges. Typically, however, parallel parking is employed only by smaller general aviation aircraft with relatively large amounts of parking space near the terminal building. In addition, cargo aircraft may parallel park at their respective cargo terminals to facilitate the loading and unloading of their respective loads.

Remote parking

Remote parking may be employed when there is limited parking area available at the terminal building itself or when aircraft parked may be stationed there overnight or for longer durations. Remote parking areas are typically comprised of a series of rows of parking spaces, sized to accommodate varying sizes of aircraft. Smaller commercial and general aviation aircraft may be boarded and deplaned from the remote parking areas with the use of shuttle buses or vans. Larger commercial aircraft are typically taxied to a close-in parking space prior to passenger loading.

3.14 The passenger handling system

The commercial airport terminal's **passenger handling system** is a series of links and processes that facilitate the transfer of passengers between an aircraft and one of the modes of the local ground transportation system. These processes include the *flight interface, passenger processing,* and *access/processing interface.*

Flight interface provides the link between the aircraft gates and passenger processing facilities. The flight interface includes gate lounges and service counters, moving sidewalks, buses, and mobile lounges; loading facilities such as loading bridges and air stairs; and facilities for transferring between flights, including corridors, waiting areas, and mobile conveyance facilities (Fig. 3.19).

Passenger processing facilities accomplish the major processing activities required to prepare departing passengers for use of air transportation and arriving passengers to leave the airport for ground transportation to their ultimate destinations. Primary activities include ticketing, baggage check, security, passport check, baggage claim, customs, and immigration. Facilities include ticketing and baggage check-in counters, baggage and passenger security stations.

Fig 3.19 Loading bridges are part of the flight interface.

Common use terminal equipment (CUTE)

Common-use ticket counters are typically configured for use by multiple air carriers. Many common-use ticketing facilities are equipped with **common use terminal equipment (CUTE),** a computer-based system that can accommodate the operating systems of any air carrier that shares the ticketing facility (Fig. 3.20). A growing number of airport terminals serving air carriers that have infrequent service to the airport, charter carriers, and international carriers have implemented common-use ticketing facilities, which provide the ability to serve more air carriers and passengers with less physical ticket counter space than their exclusive-use counterparts. The traditional processing that occurs at an airline ticket counter includes the purchasing of airline tickets for trips either on the day of purchase or for future travel, the assignment of seats, and the issuance of boarding passes. For passengers checking in baggage, the ticket counter has traditionally served as the location where bags would be checked and entered into the baggage handling system.

Fig. 3.20 CUTE (common-use terminal equipment) with variable LED and CRT signage.

Common-use Self-Service (CUSS) kiosks

Most recently, the introduction of automated kiosks by many air carriers, located near traditional ticket counters, perform many of the essential services of the traditional ticket counter, at least for those passengers traveling on electronic tickets. In addition, some airports have employed **common-use self-service (CUSS)** kiosks, which offer check-in for multiple air carriers (Fig. 3.21). Despite the vast changes in technology and policies over time, the traditional ticket counter may never become obsolete. During periods of irregularity, such as when flights are delayed or canceled, or when passengers need special assistance with their itineraries, the ticket counter often becomes the first location that passengers go to in order to find an airline representative for assistance.

Fig 3.21 Common-use self-service (CUSS) kiosks

At-gate processing

The remaining processing to be performed on a passenger prior to boarding an aircraft typically occurs at the gate area. Each air carrier has its own method of boarding passengers onto aircraft. Some air carriers board in order of fare class, first class first, coach class next. Others board passengers in order by the row number of their assigned aircraft seats (rear to front). Yet others board simply on a first-come, first-served basis. For all air carriers, however, regulations state that each passenger must show a boarding pass and government-issued photo identification to an air carrier gate agent prior to boarding. At times, gate processing has also incorporated security screening policies. Early policies employed by the Transportation Security Administration called for randomly selecting boarding passengers for additional passenger and carryon baggage screening. This policy was in the process of being phased out in the early months of 2003. In addition to boarding, passenger processing within the gate area also includes administrative issues regarding a passenger’s ticket, including seat assignment changes, requests to stand by for a flight, and any irregular issues that may arise.

Federal Inspection Services (FIS)

Passengers arriving on international flights must generally undergo customs and immigration formalities at the airport of their initial landing in the United States. **Federal Inspection Services (FIS)** conducts these formalities, which include passport inspection, inspection of baggage, and collection of duties on certain imported items, and sometimes inspection for agricultural materials, illegal drugs, or other restricted items. FIS is operated by the United States Customs Service, which, as of March 2003, was administered under the Department of Homeland Security. In recent years, introduction of streamlined procedures for returning U.S. citizens, the "red channel, green channel" system for passing through customs, and computerized access to records at inspection stations have substantially sped the flow of passengers at many airports. Flights from some Canadian and Caribbean airports are pre cleared at the originating airport, so arrival formalities are substantially reduced or eliminated.

Ancillary passenger terminal facilities

Although not technically required for passengers, ancillary, or nonessential facilities, are often provided in airports to improve the overall travel experience. Nonessential facilities include food and beverage services, retail shops, common waiting areas, information kiosks, post offices, places of worship, hotels, conference centers, bars, and smoking lounges. These facilities, known as *concessions,* when properly managed, not only offer benefits to passengers, but also may generate significant levels of revenue to support the operations of the

Airport The management of concessions within airport terminals continues to mature. At many large commercial service airports, where large volumes of passengers provide significant market potential for retail products and services, airport terminals have established concessions programs that offer brand name products and services, ranging from fast-food, to specialty items.

Many airports include concessions that promote and support the local economy. These programs may include the presence of shops that offer locally made products, or products associated with the area. In addition, many airports have DBE (Disadvantaged Business Enterprise) programs which offer minority and woman-owned businesses to set up shop in the airport, at reduced lease rates, at part of its concessions program.

By locating passenger processing facilities, both essential and nonessential, in convenient locations and in a logical order, terminal planners aim to keep passengers moving through airports with a minimal amount of confusion and congestion. To fully understand the behavior of passengers within a terminal, terminal passenger flow diagrams are constructed. Passenger flow diagrams illustrate the direction and volume of passengers traveling from one processing facility in a terminal to another. On the basis of this information, airport terminal facilities may be appropriately sized and managed to maintain efficient operations

3.15 Pavement management

For most aircraft, the presence of strong, level, dry, and well-maintained pavement surfaces are required for safe movement to, from, and around an airport's airfield. Thus, the inspection, maintenance, and repair of the runways, taxiways, and apron areas as part of an airfield pavement management program are of utmost importance to airport management. FAR Part 139, Section 139.305, covers some specific characteristics that define the minimum quality standards for airfield pavements, including:

- Pavement edges shall not exceed 3 inches difference in elevation between abutting pavement sections and between full-strength pavement and abutting shoulders.

- Pavement surfaces shall have no hole exceeding 3 inches in depth or any hole the slope of which from any point in the hole to the nearest point at the lip of the hole is 45 degrees or greater as measured from
- the pavement surface plane, unless, in either case, the entire area of the hole can be covered by a 5-inch diameter circle.
- Pavement shall be free of cracks and surface variations which could impair directional control of air carrier aircraft. completely as practicable, with exceptions for snow and ice removal operations.
- Any chemical solvent that is used to clean any pavement area shall be removed as soon as possible, with exceptions for snow and ice removal operations.
- The pavement shall be sufficiently drained and free of depressions to prevent ponding that obscures markings or impairs safe aircraft operations.
- Mud, dirt, sand, loose aggregate, debris, foreign objects, rubber deposits, and other contaminants shall be removed promptly and as

Runways are typically paved using one of two sets of materials. Runways may be constructed of **flexible (asphalt)** or **rigid (concrete)** materials. Concrete, a rigid pavement that can remain useful for 20 to 40 years, is typically found at large commercial service airports and former military base airfields. Runways made of rigid pavements are typically constructed by aligning a series of concrete slabs connected by joints that allow for pavement contraction and expansion as a result of the loading of aircraft on the pavement surface, and as a result of changes in air temperature. Runways constructed from flexible pavement mixtures are typically found at most smaller airports. Flexible pavement runways are typically much less expensive to construct than rigid pavement runways. The life of asphalt runways typically lasts between 15 and 20 years, given proper design, construction, and maintenance.

The following symptoms provide evidence of potential pavement failures:

- Pounding of water on or near pavement
- Building up of soil or heavy turf at pavement edges, preventing water runoff
- Clogged or overgrown ditches
- Erosion of soil at pavement edges
- Open or silted-in joints
- Surface cracking or crumbling
- Undulating or bumpy surfaces

FAA defines **pavement maintenance** as “any regular or recurring work necessary, on a continuing basis, to preserve existing pavement facilities in good condition, any work involved in the care or cleaning of existing pavement facilities, and incidental or minor repair work on existing pavement facilities.” Pavement maintenance involves, for example, sealing of small surface cracks.

The FAA defines **pavement rehabilitation** as the “development required to preserve, repair, or restore the financial integrity” of the pavement. Adding an additional layer of asphalt on the surface of a runway with the goal of re strengthening the pavement would be considered a rehabilitation. The FAA typically provides airport funding through the AIP program for pavement rehabilitation projects. Pavement maintenance projects are generally not eligible for AIP funding. Though approaches to repairing pavements may differ, some experts note that appropriately timed maintenance and rehabilitation forestalls the need to replace the pavement entirely, termed **pavement reconstruction,** which is a far more expensive process. An appropriate maintenance program can minimize pavement deterioration. Similarly, rehabilitation can extend the time needed until the pavement must be replaced.

3.16 Aircraft rescue and fire fighting (ARFF)

Although the incidents of fires and emergencies occurring at an airport are rare, when they do occur, especially on an aircraft, the fire fighting and rescue capabilities at the airport may mean the difference between life and death for pilots, passengers, and other airport personnel. Because of this, aircraft rescue and fire fighting (ARFF) services are strongly recommended at all airports and are required to be present at all airports operating under FAR Part 139. For those airports not operating under FAR Part 139, an agreement with local municipal rescue and firefighting agencies is necessary for safe operations. The characteristics of aircraft fires are different from those of other structures and equipment because of the speed at which they develop and the intense heat they generate. Because of this, FAR Part 139 designates specific ARFF requirements based on the type of aircraft that typically use any given airport. FAR Part 139.315 designates the *ARFF index* of an airport based on the length (from nose to tail) of air carrier aircraft that use the airport and the average number of daily departures of air carrier aircraft. ARFF index is determined by the longest aircraft that serves the airport on an average of five departures per day. Index determination based on aircraft length is as follows:

- Index A: Aircraft less that 90 feet in length
- Index B: Aircraft more than 90 feet but less than 126 feet in length
- Index C: Aircraft more than 126 feet but less than 159 feet in length

ARFF uses combinations of water, dry chemicals, and **aqueous film-forming foam (AFFF)** to fight aircraft-based and other airfield fires. FAR Part 139.317 describes the required ARFF equipment and agents to be present at the airport, based on the airport's ARFF index. These minimum requirements are as follows:

Index A airports require one ARFF vehicle carrying at least:

1. 500 pounds of sodium-based dry chemical
or
2. 450 pounds of potassium-based dry chemical and 100 pounds of water and AFFF for simultaneous water and foam application

Index B airports require either of the following:

1. One vehicle carrying at least 500 pounds of sodium-based dry chemical, and 1,500 gallons of water, and AFFF for foam production
or
2. Two vehicles, with one vehicle carrying the agents required for Index A and one vehicle carrying enough water and AFFF so that the total quantity of water for foam production carried by both vehicles is at least 1,500 gallons

Index C airports require either:

1. Three vehicles, with one vehicle carrying the agents required for Index A, and two vehicles carrying enough water and AFFF so that the total quantity of water for foam production carried by all three vehicles is at least 3,000 gallons

or
2. Two vehicles, with one vehicle carrying the requirements for Index B, and one vehicle carrying

enough water for foam production by both vehicles is 3,000 gallons

Index D airports require three vehicles, including:
1. One vehicle carrying the agents required for Index A
2. Two vehicles carrying enough water and AFFF so that the total quantity of water for foam production carried by all three vehicles is at least 4,000 gallons
Index E airports require three vehicles, including:
1. One vehicle carrying the agents required for Index A
2. Two vehicles carrying enough water and AFFF so that the total quantity of water for foam production carried by all three vehicles is at least 6,000 gallons

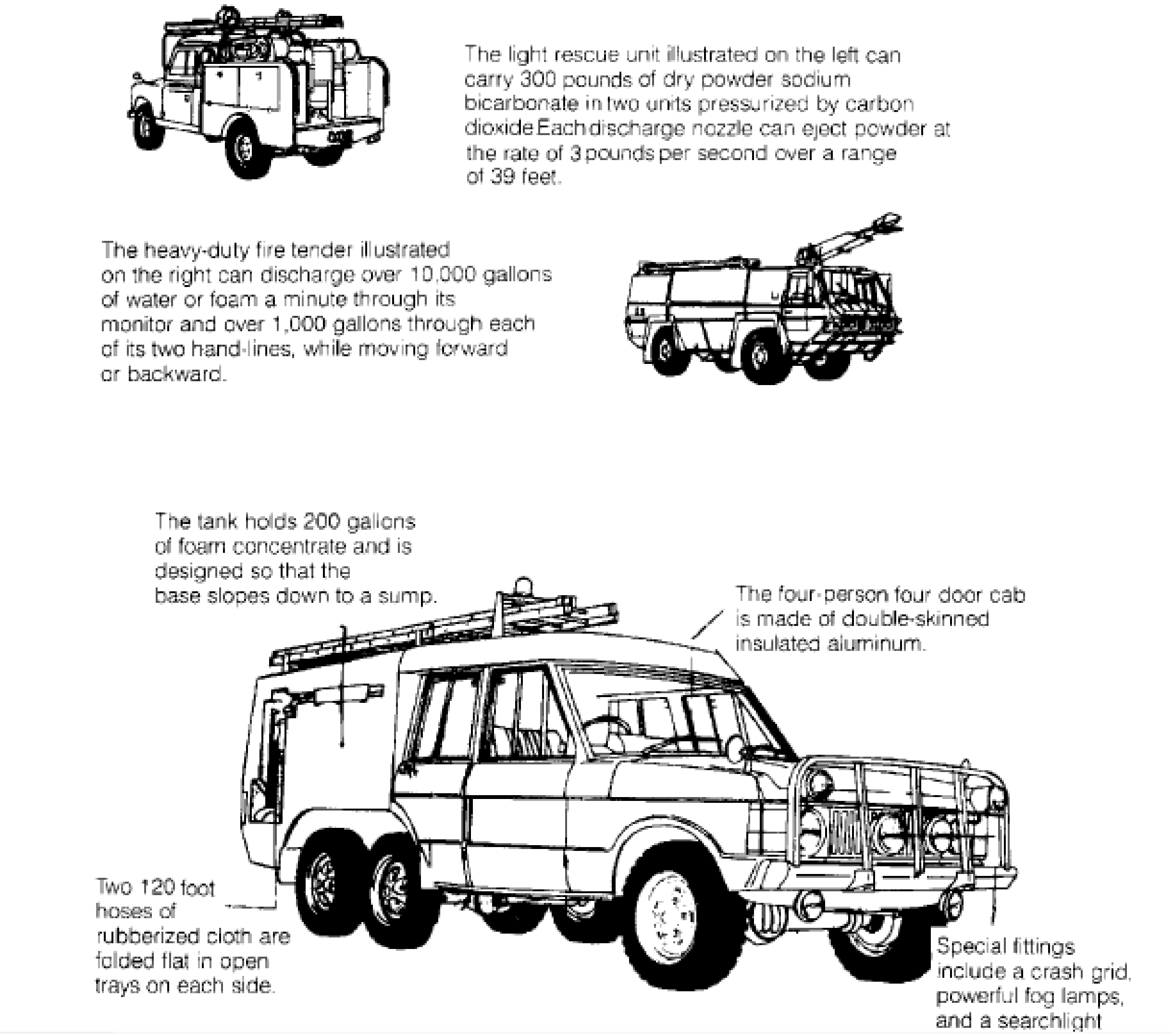

Fig. 3.12 *Typical ARFF vehicles*

Fig 3.13 Heavy duty foam tender

3.17 Snow and ice control

In many areas in the northern and mountainous regions of the United States, the removal of snow and ice from airfield pavements represents a significant portion of an airport's overall operations budget. How effective this expenditure is depends on the ability of management to plan and execute an efficient snow and ice control program. FAR Part 139.313, states specifically that all airports operating under FAR Part 139 where snow and icing conditions regularly occur shall prepare, maintain, and carry out a snow and ice control plan. The snow and ice control plan shall include instructions and procedures for:

- Prompt removal or control, as completely as practical, of snow, ice, and slush on each pavement area
- Positioning snow on movement area surfaces so that all air carrier aircraft propellers, engine pods, rotors, and wingtips will clear any snowdrift and snow bank as the aircrafts' landing gear traverses any full-strength portion of the pavement area
- Selection and application of approved materials for snow and ice control to ensure that they adhere to snow and ice sufficiently to minimize engine ingestion
- Timely commencement of snow and ice control operations
- Prompt notification of all air carriers using the airport when any portion of the pavement area normally available to them is less than satisfactorily cleared for safe operation by their aircraft

A typical snow and ice control plan tends to include:

- o A brief statement of the purpose of the plan.
- o A listing of the personnel and organizations (airport and other) responsible for the snow and ice control program: Many airports hire additional personnel during the winter months or utilize personnel from the streets and sanitation departments on an emergency basis.

- Standards and procedures to be followed: There are a number of excellent sources that airport management uses in preparation of this aspect of their snow and ice control program. They include the *Air Transportation Snow Removal Handbook*, published by the ATA, and FAA Advisory Circular 150/5200-30A, Airport Winter Safety and Operations. The AAAE also sponsors an annual International Aviation Snow Symposium at which workshops are held covering all aspects of snow removal.
- Training: Because the airport snow removal program requires special skills, a training program is normally an integral part of the plan. This includes classroom training in such areas as airport orientation, snow removal

- standards and procedures, use of various types of equipment, aircraft characteristics (capabilities and limitations), description of hazards and problem areas at the airport, communications, and safety procedures.
- On-site training includes a review of operational areas and hazards, test runs with equipment to accustom operators to area dimensions and maneuvering techniques, and communications practice while on the job.

UNIT- IV
AIRPORT TECHNICAL SERVICES AND AIRPORT ACCESS

Various operational services found at air carrier airports and be conveniently grouped together under this general heading. They are concerned with the safety of aircraft operations in terms of control, navigation and communications, and information.

4.1 Safety Management System

Airports Council International (ACI) agreed with the principle of certification in accordance with ICAO standards, but stated that “in the context of the ICAO programme of safety audits for airports, Recommended Practices, for airport design should not become ‘de-facto’ Standards for airport operation, since they do not have same status as Standards, may be difficult to apply to existing airports (notably those concerned with airfield dimensions), and are not based on a defined and consistently-applied ‘target level of safety”.

Fundamental Changes

Air traffic control (ATC) capability was already under scrutiny in the 1970s, in that it was questionable that existing paradigms could ever provide capacity that would be consistent with demand. The concern was both in terms of peak movement capacity and the minimization of environmental impact. The latter has become increasingly relevant over subsequent time.

In 1983, ICAO established a special committee on the future air navigation system (FANS), and while the name implied that it terms of reference were limited to the navigation function, it was charged with developing very wide-ranging operational concepts for ATC.

The newer-generation systems have since evolved under the title air traffic management (ATM). The FANS report was published in 1988 and laid the basis for the industry’s future strategy for ATM through digital communication, navigation, and surveillance (CNS) using satellites and data links.

Function of ATC

The primary purpose of ATC is the prevention of collisions between aircraft in flight and also between aircraft and any obstructions either moving or stationary on an airport. Additionally, it is concerned with promoting an efficient flow of air traffic.
Efficient flow has tended to mean using up to the maximum capacity available in airspace, accepting that as the capacity limit is approached there will be an increasing level of delay.

International ATC Collaboration

These have been considerable change over time in the way that the air traffic service function has been viewed internationally. Whereas it was always a “national” service, the advantage of imposing pan national service-quality attributes has been long recognized. In Europe in 1960, Euro control was formed as a unit funded by national governments to address the fundamental operational issue of the control of aircraft in the physically restricted volume of airspace over Belgium, the Netherlands, and Luxembourg (Benelux countries) This resulted in the successful establishment of an ARTCC at Maastricht, in the Netherlands, that had control authority over the Benelux region and the upper airspace regions of northern Germany (at that time the Federal Republic of Germany (West Germany).] An attempt to spread the application of this philosophy at Karlsruhe, in southern Germany, was not as successful, and this ARTCC was later placed into German ownership.

4.2 Flight Rules

There are three sets of flight rules depending on the circumstances listed:

- General flight rules: Observed by all aircraft in any class of airspace.
- Visual flight rules (VFR). Observed by aircraft flying in weather conditions equal to or above prescribed limits.
- Instrument flight rules (IFR). Observed by aircraft in weather conditions below VFR limits and/or in Class A airspace.

General Flight Rules

As the name implies, these rules refer to the conduct of flight in such general matters as the safeguarding of persons and property on the ground, avoidance of collision, right-of-way rules, and air-craft navigation lights. Details are listed in the various regulatory documents of each country. For example, in the United States, this is Part 91 of the Federal Aviation Regulations; the appropriate regulation in the United Kingdom is achieved by means of the Air Navigation: Order and Regulations.

Visual Flight Rules

In addition to observing the general flight rules of the air, each flight has to be conducted according to either visual flight rules (VFRs) or instrument flight rules (IFRs). In the case of VFRs, the flight is conducted on a see-and-be-seen basis in relation to terrain and other aircraft. It is therefore necessary for a pilot to have certain minimum weather conditions known as visual meteorological conditions (VMCs). Anything worse than these conditions is referred to as instrument meteorological conditions (IMCs). General international usage is VFR and IFR conditions.

Instrument Flight Rules

When visibility and/or proximity to clouds are less than the quoted VFR limits (VMC), flight has to be conducted under IFRs. With respect to flight under IFRs in controlled airspace, the rules require that ATC must be notified of flight details in advance by what is known as an ATC flight plan.

4.3 Meteorology
Function

Aviation meteorological services are provided by governmental organizations in all ICAO Member States, and their services are organized to conform to ICAO Annex 3. Some countries employ their military to produce aviation-related weather products, but most use the civil meteorological organization.

World Area Forecast System

The World Area Forecast System was established by ICAO and the world Meteorological Organization (WMO) in 1982 with the purpose of providing worldwide aeronautical forecasts in a standardized form. The main task of the WAFCs is to provide significant weather forecasts as well as upper-air forecasts (grid-point forecasts) in digital form and on a global basis.

Meteorologic Observations and Reports

Meteorologic observations are vital to forecasting, and reports are generated by meteorologic services worldwide. In context with aviation four types of routine observations of surface weather have been established by ICAO and are produced in either hourly or half-hourly intervals at many airports and partly at other geographically relevant sites.

- Aviation routine weather report (METAR)
- Aviation selected special weather report(SPECI)
- Local routine met report (met report)
- Local special met report (special)

4.4 METAR and SPECI

Obtained from aircraft in flight provide valuable information about weather conditions in The METAR is the most common surface weather report for aviation purposes.

Usually METARs are disseminated at half-hour intervals, although some stations only produce METARs hourly.
The METAR includes the following data:

- Station identification and time of observation
- Surface wind direction and speed (direction in true north)
- Visibility
- Runway visual range (RVR) when appropriate and available
- Present weather
- Cloud amount and type [only cumulonimbus and towering cumulus (CB and TCU)]
- Temperature and dew point
- QNH or atmospheric pressure above mean sea level (amsl)
- Supplementary information
- Trend forecast
- Remarks when applicable (national dissemination only)

4.5 Aircraft observations and Reports

Meteorologic data places where either no surface or upper-air observations are available or no observation is possible.

Pilot Reports (PIREPs)

The pilot report is a weather observation by an air crew relayed to ATC via either voice communications or ACARS data link. It contains the following elements.

- Message identifier (UA or UUA) for routine or urgent messges.
- Position and flight level of the observing aircraft
- Time of report
- Aircraft type (important for reports on icing or turbulence)

Possible weather data include

- Wind direction and speed [(true north or magnetic north (United States)]
- Cloud cover
- Icing (light, moderate, or severe)
- Turbulence (light, moderate, or severe)
- Temperature
- Visibility
- Remarks

Significant Weather Forecasts and Charts

Significant weather forecasts (SIGWXs) and charts (SWCs) as well as upper-air forecast charts are generated and disseminated by the world area forecast centers (WAFCs) in London and Washington. They are then produced and locally distributed by the national meteorology authorities. Where local distribution is not available, the charts provided by the WAFCs are usually used.

4.6 Aeronautical Information

Scope

The complexities of civil aviation are such that it is almost impossible to conduct a flight of any kind, even a short GA flight, without having recourse to considerable amount of aeronautical information such as ATC requirements (including airspace restrictions), airport layout, hours of operation, and availability of fuel.

These specify that an aeronautical information service is responsible under international agreement for

- The preparation of an aeronautical information publication (AIP)
- The origination of NOTAMs
- The origination of aeronautical information circulars (AICs)

Urgent Operational Information

NOTAMs are urgent notices for the attention of flight crews and operations personnel.
NOTAMs are distributed electronically. This replaces the previously used methods of teleprinter or fax, and while these are still the media used in remote areas, most nowadays will get very rapid electronic dissemination worldwide.

4.7 Access as part of the Airport System

Few years ago, It was customary for airport operators to consider that the problem of getting to the airport was chiefly the concern of the urban or regional transportation planner and the surface transport operators.

Congestion and difficulties in accessing airports have, as will be seen, very strong implications on their operations. Therefore, the airport administrator has an unavoidable vital interest in the whole area of access and accessibility, perhaps one of the most difficult problem areas to face airport management. Figure below is a conceptualized diagram indicating how potential outbound passengers and freight traffic

Through an airport will be subject to capacity constraints at the various points in the system; a similar chain operates in reverse for inbound traffic.

Lack of access capacity is far from being a hypothetical occurrence. Several of the world's major airports already face severe capacity constraints in the access phase of throughput. Using direct traffic-estimation methods, urban transport planners can show that some of the most severe access problems can occur at airports set in the environment of large metropolitan areas, if these airports depend largely on road access.

Department of Airports proposed that the total number of aircraft operations should be determined as follows:

Where
AEDT=average number of vehicles entering the central terminal area in the prior six months.
ANPO=average number of annual passengers per actual air operation in the prior six months.
ASOP=actual number of air operations divided by the proposed number for the prior six months.
CHTF=critical-hour traffic factor: the three-hundredth highest hour of vehicular traffic during the prior 12 months divided by the average number of vehicles entering the central terminal area daily.
MTAO= Maximum Takeoff and Approach operations
PPV=average number of air passengers per inbound vehicle
RCAP=entering central terminal area roadway capacity in terms of vehicles per hour
0.90=constant.

This procedure was an attempt to ensure that the scheduled airside activities would not impose unacceptable loads on a landside access system.

At nearly all airports, much of the access system in terms of the highways, the urban bus and rail systems, and taxis is outside the control of the airport administrator, both financially and operationally

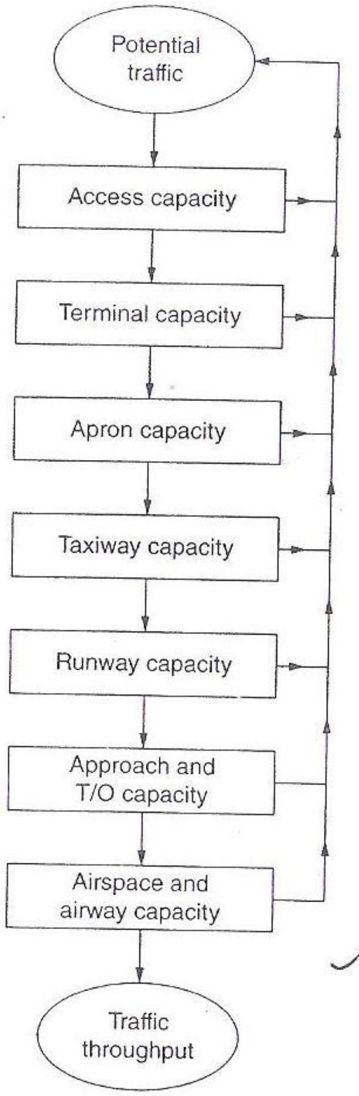

Figure 4.1 Sequential capacity constraints on outbound airport throughput.

Access users and modal choice

Airport passengers often, but not always, constitute the majority of persons entering or leaving an airport. Excluding individuals making trips as suppliers to the airport, the airport population can be divided into three categories.

- Passengers-originating, destined, transit, and transfer.
- Employees-airline, airport, government, concessionaires and such
- Visitors-greeters, senders, sightseers, and such

The transit and transfer passengers make use of the access system. There is no single figure for the division of the airport population among these categories. Among airports and depends on such factors as the size of the airport; and the type of air service supplied. Large airports with large base airline fleets have extensive maintenance and engineering facilities.

Over the past 50 years, a number of superficial solutions have been proposed for the access problem, many of which have involved the use of some dedicated high-speed tracked technology to link the airport with the city center in an effort to reduce the demonstrated dominance of the automobile.

Consequently, the airport traveler competes with the urban dweller for road space and transit capacity during peak-hour periods. The passenger using the automobile, taxi, and bus, this means delay through congestion; for those using urban and intercity rail systems, it means possible difficulties in finding seats and handling baggage in crowded facilities.

Rail has been used successfully in connecting two major new European airports, Munich and Oslo. The rail connection of Changi Singapore to the Singapore rail network is also a significant success, but the length of the network is necessarily small in the island republic.

Experiences in Europe of connecting directly into the high-speed rail (HSR) systems have shown varied success even in the same country.

Access Interaction with Passenger Terminal Operation

The method of operation of the passenger terminal and some of the associated problems of terminal operation depend partly on access in as much as this can affect the amount of time that the departing passenger spends in the terminal. it is the departing passenger who places most demands on the airport terminal system. Departing dwell times depend chiefly on the length of access time, reliability of access time, check-in and security search requirements, airline procedures, and the consequences of missing a flight.

Length of Access Time

It is likely that the amount of time for a particular access journey is a random variable that is normally distributed about its mean value. The variance of the individual journey time about the mean is in some way proportional to the mean.

Reliability of Access Trip

The effect of reliability on departing terminal dwell times is shown in Figure 13.4 if these are two access trips each with the same mean trip time of t but with standard deviations of tan dt, it can be seen that the mean terminal dwell time, under assumptions of normality and 99.5 percent arrivals by K minutes before STD, are t and t respectively.

Check-in Procedures

Check-in requirements are not the same for all flights. For many long distance international flights, check-in times are a minimum of one hour before scheduled time of departure, whereas for domestic and short-haul international flights, this is usually cut to 30 minutes. With long-haul passengers spending an average of 22 more minutes in the terminal than short-haul passengers. Similar differences are often observed between check-in procedures for chartered and scheduled passengers. The effect of longer closeout times is to increase passenger dwell time in the terminal prior to departure.

Consequences of Missing a Flight

Depending on the type of flight and the type of ticket, the passenger will have a very different attitude toward arriving after the flight has closed out and consequently missing the aircraft. This can be exemplified by considering a hypothetical trip maker making three different flights from Tampa international Airport. The first flight is on a normal scheduled ticket at full fare to Milami; the second is on a normal scheduled full-fare ticket to Buenous Aires; and the third is a special chartered holiday flight to London.

The implications of missing the three flights are not at all the same. Should the passenger miss the first flight, there will soon be another flight, and there is no financial loss.

In the case of the second flight, the ticket remains valid, but because the connections will now be lost and there might not be an alternative flight rapidly available, there is serious inconvenience and maybe some financial loss.

Missing the third flight, however, could cause much inconvenience through a spoiled holiday and serious financial loss because the ticket is no longer valid. The passenger therefore will arrange his or her arrival at the airport in such a way that the risk of missing each flight is different.

In the arrival patterns at individual airports are a mixture of all these factors. The variation between arrival times can be seen in figure, which shows the cumulative arrival curves for four European airports. Its access times were reasonably predictable, and most flights were short haul.

Research examining the effect of the length and reliability of access times has confirmed that unreliable access times can cause congestion in the check-in area and long dwell times in the departure lounges.

The manner in which access is provided to the passenger becomes critical to the operation of airport terminals at many vacation locations. Airports such as Punta Cana in the Dominican Republic and Palma, Majorca, have large landside deliveries of passengers at times that have little to do with the scheduled time of departure of their flights.

It is not uncommon for departing passengers to be delivered, by fleets of charter buses, to the departures area several hours before the scheduled time of departure, even before the check-in desks and baggage-drop facilities are open for their flights.

4.8 Access Modes

Automobile

In most developed countries, the private car is the principal method of accessing airports. Since the inception of commercial air transport and the situation seems most unlikely to change in the foreseeable future. Airports must integrate a substantial parking capability into their design and operation.

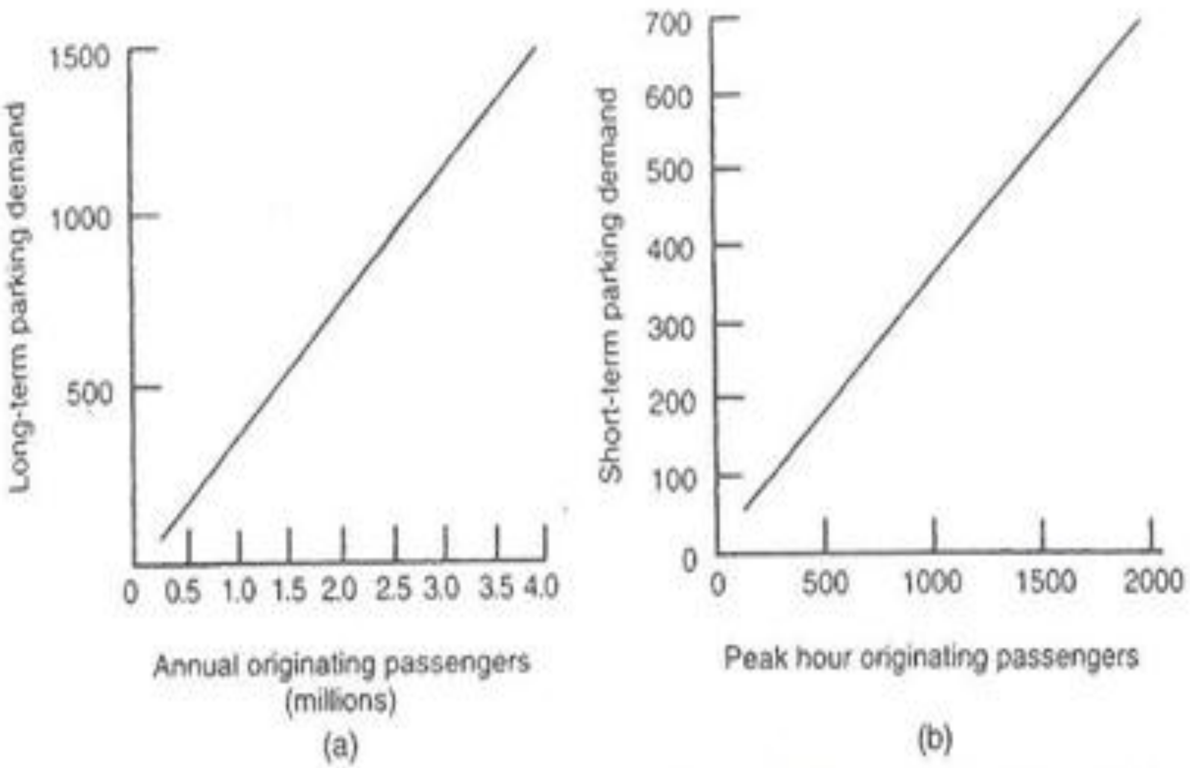

Figure 4.2 Airport growth

As airports grow in size, it becomes difficult to provide adequate parking space within reasonable walking distance of the terminals. In the case of centralized operations, it is common to divide the parking areas into short-term facilities close to the terminal and both medium-and long-term parking areas often served by shuttle services.

Serious internal circulation congestion can limit the airport's capacity if too many cars attempt to enter the facilities close to the terminal, a condition that has caused problems with the operation of the Terminal 1 at Paris Charles de Galle airport, where parking is integral to the terminal, and access is via a tunnel under the apron.

Major airports relying overwhelmingly on the automobile as the major access mode find that it is not solely in the matter of supplying and operating car parking that this decision materially affects the operation of the passenger terminal.

The first solution leads to highly decentralized passenger terminal complex with possible difficulties in interlining, especially for baggage-laden international passengers. The second solution almost certainly will lead to the segregation of departing and arriving passenger flows throughout the terminal building.

Taxi

For the air traveler, the taxi is perhaps the ideal method of accessing the airport from all aspects except one-cost. In general, this mode involves the least difficulty with baggage, is highly reliable, operates from a real origin or destination, and provides access directly to the airport curbside.

The airport has an interest in maintaining a reasonable balance of supply and demand of taxis at the airport.

Many airports do not permit taxis to pick up a fare on airport property without a special license, for which the taxi operator must pay annually. In the United Kingdom, it is recent common practice for taxis to incur a charge for both a drop-off and a pickup an airport. As airports become large, it is not unusual that they suffer from too many cruising taxis, which cause congestion on the terminal access roads.

Limousine

Limousine services, which are reasonably common in the United States and number of other countries, are either minibuses or large automobiles that provide connection between the airport and a number of designated centers (usually hotels) in the city.
In small cities, the limousine usually operates to only one central location; in larger cities, to designated multiple locations.

Operationally, a limousine is similar to a bus, and where bus services are feasible, it is unusual to have limousines as well. The contracts are lucrative to the limousine operator because passenger load factors are high, and therefore, the concessionary fees that go to the airport operator can be high in comparison with the cost of providing facilities. Because limousines are in fact a form of public transport, they relieve road congestion and the need for parking.

Rail

In the last 20 years, there has been a great deal of activity at large airports to move in the direction of providing more access by rail (TRB 2000,2002). Airports are widely spread across the globe as Chicago O'Hare, JFK, London Heathrow, Hong Kong, Beijing, Singapore, and Seoul Incheon are just some of the airports that have added rail access routes. The rail access facilities fall into three categories.

Provision of a connection into an existing rail rapid-transit system for example, Atlanta, Chicago O'Hare, Ronald Reagan Washington National, Paris Charles de Gaulle, and London Heathrow.

Direct connection to an existing national intercity rail network-for example, Zurich Kloten, Schiphol Amsterdam, Franfurt, London Gatwick, and Brussels.

Dedicated link from airport to city center location or locations-for example, Munich, Oslo, Beijing, Inchon, and Shanghai.

If rail services is to be successful for all three rail modes (i.e., urban rapid transit, conventional intercity rail, and dedicated links), it requires a compact connection at the airport end.

The access rail system and any system to which it connects must be able to accommodate storing of luggage on the trip.

Access time, provided that it is reasonable for the distance covered, is not extremely important to passengers, so the cost of supplying very high speeds may not be worth striving for.

Access journey time does not appear to be critical to air travelers, except in the very shortest hauls with competitive surface modes. The selection of an access mode is much more affected by the ability to cope with inconvenient and heavy baggage and the total cost to the traveling party.

Bus

Around the world, virtually all airports carrying reasonable volumes of passengers by scheduled and charter operators are connected by bus to the city center. Normally this is arranged by contract between the bus operator and the airport authority whereby the bus company usually pays the airport a concessionary fee or percentage for the exclusive right to provide an agreed-on scheduled service. Service is supplied to a number of point in large cities but perhaps to only one point in a small urban area.

Buses become extremely important at airports serving many resorts. Bus loading and unloading areas are designated and must be kept clear of taxis and automobiles. Bus parks are as important as car parks, and the airport operator has an interest in ensuring that the bus parks are kept operational and clear. Figure shows bus park that caters to chartered buses forvacation passengers.

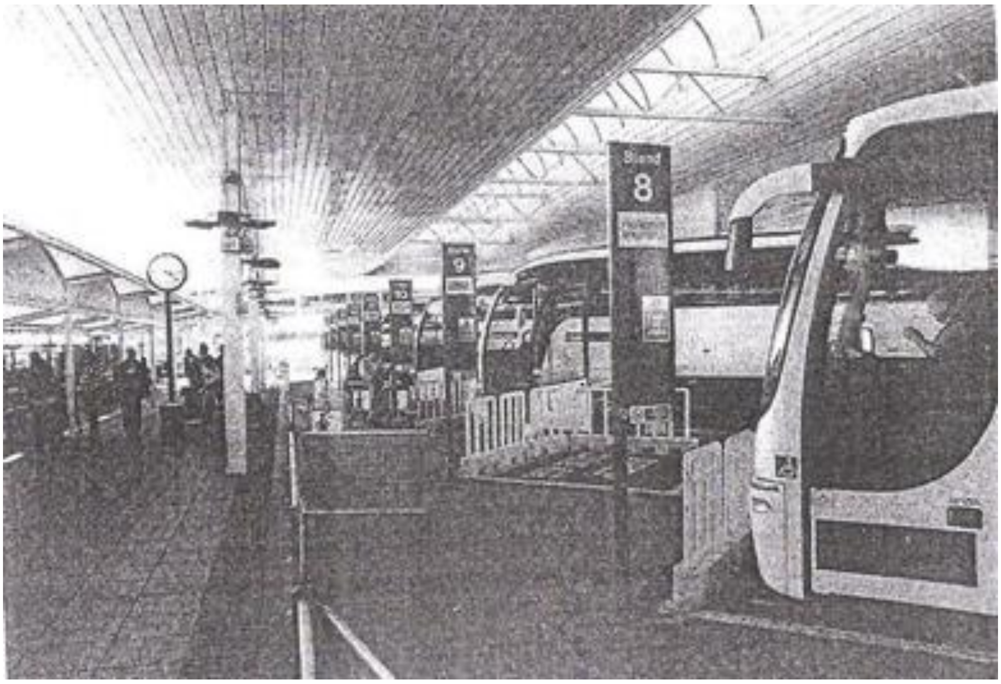

Figure 4.3 Bus

Dedicated Rail Systems

In the area of airport access, nothing has caught the public imagination more than the concept of some form of futuristic high-speed, tracked vehicle that will convey passengers from the airport to the town center unimpeded by surface-road or rail traffic. High-speed tracked airport-access vehicles on dedicated rights-of-way are unlikely to be built anywhere in the world where the economics of access costs are correctly considered. High-speed links are unnecessary, save little time over trains operating nonstop at conventional speeds, are likely to cost half as much as the remote airport they purport to serve, and can move passengers only to and from the central city, where most travelers probably have no wish to go.

More-over, if they require public subsidy, they raise an ethical question as to whether the air traveler has any right to expect to travel to the urban area at a higher speed than any other traveler. Even so, it is likely that they will continue to receive a disproportionate amount of public and media interest.

4.9 In-Town and Other Off-Airport Terminals

Experience with in-town terminals with check-in facilities has been varied. Originally opened in 1957, when the West London Terminal serving Heathrow was closed, only 10 percent of passengers were using the facility. As well as being uneconomic, it was difficult to have reliable connections between the off-airport terminal and the airport owing to increasing road congestion on the airport access routes. Examples of successful in-town airline bus terminals with no check-in facilities are more numerous.
Because of the availability of online ticketing and online check-in, there has been little recent development in remote check-in by the airlines. attractive service can perform poorly if the convenience level of the traveler is debased by long walking distances with baggage, frequent changes of level by stairs, crowded vehicles, and inadequate stowage space.

4.10 Factors Affecting Access-Mode Choice

The level of traffic attracted to any access mode is function of the traveler's perception of three main classes of variables:

- Cost
- Comfort
- Convenience

Decisions in terms of these variables are made not only on the level of service provided by a particular mode but also on the comparative level of service offered by competing access modes.
Transportation planners have numerous models ranging from the simple to the complex to explain the modal selection procedure.

The present-day air traffic control management and operating infrastructure

4.11 Air Traffic Control System Command Center

At the top of the air traffic control operational hierarchy is the **Air Traffic Control System Command Center (ATCSCC).** The ATCSCC provides macro level management of every aircraft currently in the national airspace system, as well as those aircraft with itineraries planned hours into the future. The ATCSCC in its current form was established in 1994 and currently resides in Herndon, Virginia. The role of the ATCSCC is to manage the flow of air traffic within the continental United States. The ATCSCC regulates air traffic when weather, equipment, runway closures, or other impacting conditions place stress on the National Airspace System. In these instances, traffic management specialists at the ATCSCC take action to modify traffic demands in order to reduce potential delays and unsafe situations in the air. Some of the strategies used by ATCSCC include the implementation of speed restrictions on aircraft, and imposition of ground delay programs, known as *ground holds*, on aircraft. Under a ground delay program, aircraft destined for an airport with potential delays upon arrival time will be held at its originating airport in order to avoid congestion and delays on route.
The ATCSCC's Airport Reservation Office (ARO) processes all requests for aircraft operating under instrument flight rules (IFR) at designated high-density traffic airports and allots reservations on a first-come first-served basis. As of 2003, four airports were considered high-density airports. They are John F. Kennedy International Airport and LaGuardia Airport in New York, Chicago's O'Hare International Airport, and Ronald Reagan Washington National Airport in Washington, D.C. The ARO also allocates reservations to and from airports with above-normal traffic demand because of special events, such as the Olympics, the upper bowl, NASCAR events, and the like. By implementing a Special Traffic Management Program (STMP), the ARO controls the number of operations generated by an event,

allowing for a limited number of reservations
in specific time intervals (Fig. 4.1).

Fig. 4.1 *FAA Air Traffic Control System Command Center*

The basics of air traffic control

Aircraft flying between airports within the United States operate under varying levels of air traffic control, depending on the location and altitude at which they are traveling and the weather conditions while in flight. In many areas of the United States, particularly at low altitudes around unpopulated areas, aircraft may fly under no direct control by ATC. In contrast, in poor weather conditions, around busy air traffic areas, and at high altitudes, aircraft must fly under *positive control*, where altitude, direction, and speed of aircraft are dictated by air traffic controllers.

Visual flight rules (VFR) versus instrument flight rules (IFR)

One factor that determines the level of control an aircraft will be subject to depends, in part, on the type of flight rules the aircraft is operating under. The flight rules, in turn, depend, in part, on the weather conditions during flight.

Under weather conditions where the visibility is sufficient to see and avoid other aircraft, and the pilot can keep the aircraft sufficiently clear of clouds, the pilot may operate under **visual flight rules (VFR).** When visibility is insufficient or a pilot's route takes the aircraft through clouds, the aircraft must fly under **instrument flight rules (IFR).** While flying under VFR, there are often times when positive control by ATC is unnecessary; under IFR, positive control is mandated.

4.12 Airspace classes

The visibility and cloud clearance criteria determining whether or not an aircraft must fly under IFR versus VFR depends largely on the class of airspace through which the aircraft will be flying. The airspace class of any given location in the United States is defined by the FAA and identified by pilots by referencing
air traffic control maps, called *sectionals, terminal area charts,* or *aeronautical charts.* It is important

for airport management, as well, to identify the class of airspace under which their airport lies, for it certainly has an impact on aircraft operations at the airport. Since 1993, airspace has been classified as either Class A, Class B, Class C, Class D, Class E, or Class G airspace (Fig. 4.2).**Class A** airspace, known as **Positive Control Airspace** prior to 1993, is located continuously throughout the continental United States, including the waters
surrounding the continental United States out to 12 miles from the coastline, and Alaska, beginning at an altitude of 18,000 feet above sea level (MSL) up to 60,000 feet MSL (known as FL 600). Unless otherwise authorized, all aircraft operating in Class A airspace must operate under IFR.

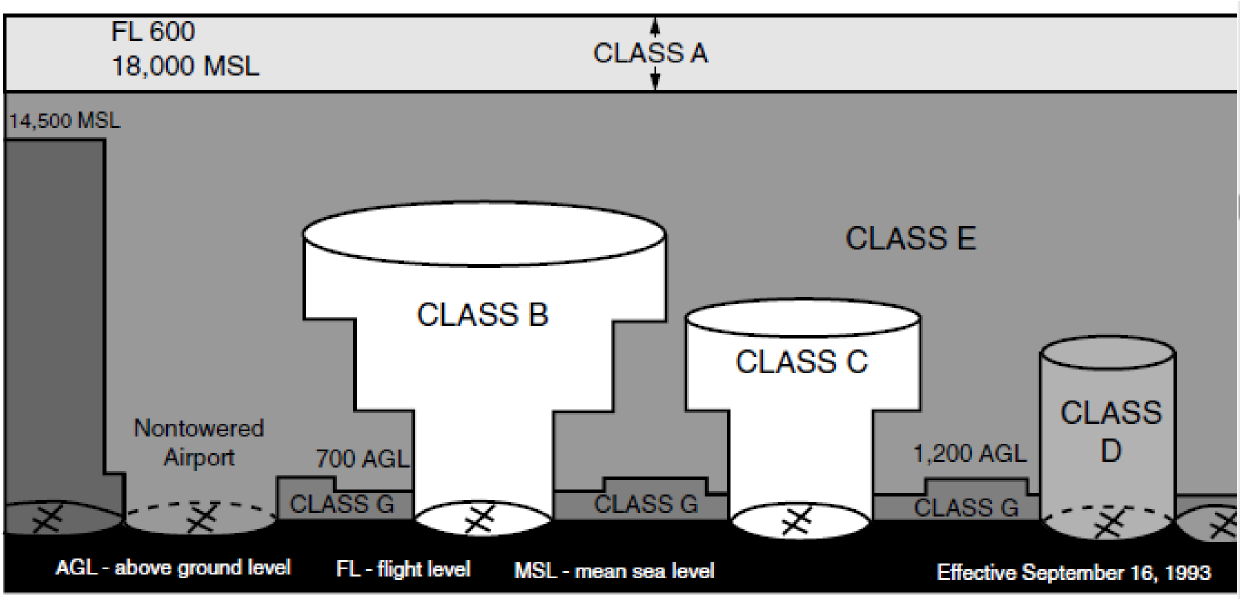

Fig. 4.2 *Airspace classifications*

Class A airspace is controlled by ATC at Air Route Traffic Control Centers (ARTCCs). There are 21 ARTCCs in the United States, each controlling one of 20 contiguous areas in the continental United States, and the area surrounding Alaska.

Class B airspace,
known as **Terminal Radar Service Areas (TSRA)** prior to 1993, surrounds the nation's busiest airports (in terms of commercial passenger enplanements or IFR operations). The configuration of each Class B airspace
area is specific to each area, but typically consists of a surface area and two or more layers of controlled airspace. The shape of Class B airspace is often described as an "upside down wedding cake." Generally, Class B airspace centers around the busiest airport in the area, extending from the surface to 10,000 feet MSL. Aircraft must be granted permission to fly within Class B airspace. Aircraft flying under VFR must be able to remain clear of clouds while in Class B airspace. All aircraft flying in Class B airspace fly under the control of ATC. Class B airspace is identified by thick dark blue lines, and altitude designations
on aeronautical charts (Fig. 4.3).

Class C airspace, known as **Airport Radar Service Areas (ARSA)** prior to 1993, surrounds those airports that serve moderately high levels of IFR operations or passenger enplanements. Class C is generally considered areas of moderate air traffic volumes, but not as busy as Class B airspace. Class C airspace is
usually centered around an airport of moderately high volumes of traffic, ranging from the surface to

4,000 feet above the airport's elevation within 5 miles of the airport, and from 1,200 feet above the surface to 4,000 feet above the surface from 5 to 10 miles from the airport. Class C airspace is also in the form of above, and 2,000 feet horizontally from any clouds. ATC will control aircraft flying under both VFR and IFR to maintain adequate separation from other aircraft under IFR. Aircraft flying VFR are responsible to see and avoid any other traffic. Class C airspace is identified by solid magenta rings and altitude designators on aeronautical charts.

Fig. 4.3 Class B airspace.

Fig. 4.4 Class C Airspace

Class D airspace

Class D airspace known as Airport Traffic Areas or **Control Zones** (CZ) prior to 1993, surround those airports not in Class B or Class C airspace but do have an air traffic control tower in operation. Class D airspace is generally a cylindrical area, 5 miles in radius from the airport, ranging from the surface to 2,500 above the elevation of the airport. Unless authorized, each aircraft must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter maintain those communications while in the airspace. While IFR traffic is controlled by ATC to maintain adequate separation in the airspace, VFR traffic generally is not, except when performing runway operations (takeoffs or landings). In order to operate VFR in Class D airspace, pilots must have at least 3 miles of visibility and be able to remain at least 500 feet below, 1,000 feet above, and 2,000 feet horizontally from clouds.

Air traffic control towers

As of 2003, over 400 airports in the United States were equipped with air traffic control towers. The vast majority of these ATCTs are directly managed by the FAA, although there are an increasing number of ATCTs operated by private companies at smaller airports. These airports are part of the FAA's Contract Tower Program, which provides funding to airports to construct and support the operation of federal contract towers (FCTs). Services provided to airports under the Contract Tower Program are identical to that of Federal

ATCTs, with the exception that they do not control traffic under IFR, but tend to have operating costs approximately half their federal counterparts. Under the federal Contract Tower Program, "low-density airports" are eligible to participate in the program.

Class E

Class E airspace, known as General Controlled Airspace prior to 1993, generally exists in the absence of Class A, B, C, or D airspace extending upward from the surface to 18,000 feet MSL within 5 miles of airports without control towers. In other areas, Class E airspace generally exists from 14,500 feet MSL to 18,000 feet MSL over the contiguous United States, including the waters within 12 miles off the coast, and Alaska. In addition, federal airways, known as Victor Airways, and Jet Routes, which generally exist from 700 or 1,200 feet above the ground (AGL) are considered Class E airspace. Only aircraft operating under IFR receive positive control in Class E airspace. VFR traffic is responsible to see and avoid all traffic. All aircraft operating under VFR must have at least 3 miles of visibility and be able to remain at least 500 feet below, 1,000 feet above, and 2,000 feet horizontally from clouds at altitudes below 10,000 feet and must have at least 5 miles of visibility and remain 1,000 feet above, 1,000 feet below, and 1 mile clear of clouds at or above 10,000 feet MSL.

Class G

Class G airspace, known as Uncontrolled Airspace prior to 1993, encompasses the airspace in the absence of Class A, B, C, D, or E airspace. This limited area typically reaches from the surface to 14,500 feet MSL in areas that aren't part of federal airways, and from the surface to 700 or 1,200 feet AGL in areas that are part of federal airways. Many remote airfields lie under Class G airspace, and hence have the very basic minimum of air traffic control services, if any at all. Aircraft flying in Class G airspace receive air traffic control assistance only if the workload on air traffic controllers permits. Aircraft flying under IFR generally do not operate in Class G airspace. Aircraft flying under VFR are responsible to see and avoid all other aircraft, must have at least 1 mile of visibility, and be able to remain clear of clouds when flying in daylight conditions below 1,200 feet AGL.

At night, when operating under 1,200 feet AGL, VFR aircraft must have at least 3 miles of visibility, and be able to remain 500 feet below, 1,000 feet above, and 2,000 feet horizontally from clouds. When

operating at altitudes above 1,200 feet AGL but less than 10,000 feet MSL, aircraft operating in Class G airspace require
at least 1 mile of visibility during the day, and 3 miles of visibility at night, and be at least 500 feet below, 1,000 feet above, and 2,000 feet horizontally clear of clouds. When operating at or above 10,000 feet MSL, and 1,200 feet AGL (at areas of high ground elevation, it is possible to be flying at greater than 10,000 feet
MSL and less than 1,200 feet AGL), aircraft in Class G airspace must have at least 5 miles of visibility and remain at least 1,000 feet below, 1,000 feet above, and 1 mile horizontally clear of clouds.

Free flight

Free flight is a concept for safe and efficient flight operating capability under IFR in which pilots have the freedom to select their own path and speed in real time. Air traffic restrictions are imposed only to ensure separation, to preclude exceeding airport capacity, to prevent unauthorized flight through special-use airspace, and to ensure the safety to flight. Restrictions are limited in extent and duration to correct the identified problem. Any activity that removes restrictions represents a move toward free flight. The transition to free flight requires changes in air traffic philosophies, procedures, and technologies. The principal philosophical change required for free flight is a shift from the concept of air traffic control (ATC) to **air traffic management (ATM).** ATM differs from ATC in several ways: the increased extent of collaboration between users and air traffic managers, greater flexibility for users to make decisions to meet their unique operational goals, and the replacement of broad restrictions with user-determined limits and targeted restrictions only when required.

4.13 Communications

NAS modernization intends to reduce the required amount of voice-to-voice communication between aircraft and ground facilities with the implementation of electronic data transfer between the flight deck and air traffic management systems using digital data link technology. Changes in the communication system will create the following capabilities:

• Integration of voice and data communications
• More efficient use of the existing radio frequency spectrum available to civil aviation
• Improved quality and clarity of ATC messages to aircraft
• Enriched flight and traffic information services, such as weather graphics and proximity traffic data
• Seamless communications across all operational domains (airport, terminal, en route, and oceanic)
• Information sharing with all NAS users
• An effective interchange network to support dynamic usage

Flight Information Service (FIS) and Cockpit Information System (CIS)

The **Flight Information Service (FIS)** used a ground-based data server and data links to provide a variety of nonoperational control information to the cockpit such as weather products, traffic information, SUA status, NOTAMs, and obstruction updates. The **Cockpit Information System (CIS)** processes and displays FIS information and integrates it with navigation, surveillance, terrain, and other data available in the cockpit. When fully operational, the CIS will also be capable of sending and receiving route requests via data link to the air traffic controller. Weather information will be obtained via data link from a ground-based source or from other aircraft. SUA information may be stored prior to flight or may be updated in real time while in flight. The primary capacity benefits of FIS and CIS technologies are enhanced situational awareness leading to greater flexibility and predictability, and reduced delays resulting from improved planning and more direct routes made possible by current and accurate traffic, environmental, terrain, and NAS resource information. The FAA does not expect to provide significant FIS until deployment of NEXCOM.

Navigation

In recent years, navigation has become increasingly reliant on the satellite based **Global Positioning System (GPS).** Contrary to the traditional ground based navigation systems such as NDBs, VORs, and ILSs, GPS is a space-based radio positioning, navigation, and time-transfer system. GPS was developed and is maintained by the U.S. Department of Defense, primarily for the military and activities associated with national defense. In July 1995, GPS gained full operational capability for civilian use, although with reduced accuracy. Since
1995, GPS navigation has been used at increasing volumes, particularly in seafaring transportation, aviation, and even automobiles.

GPS consists of three segments, space, control, and user. The *space segment* consists of 24 NAVSTAR satellites (21 in active use and 3 spare) placed in circular, geosynchronous orbits, 10,900 nautical miles above the earth. The satellites are positioned so that at least five satellites are always "in view" to a user no matter where that user is on the earth. The satellites continuously broadcast navigation signals, identifying their positions, which are used by GPS receivers to calculate position information at the receiver location. Five monitor stations, three uplink antennas, and a master control station located at Falcon Air Force Base in Colorado Springs, Colorado, make up the *control segment.* The stations track all GPS satellites and calculate precise orbit locations. From this information, the master control station issues updated navigation messages for each satellite, thus maintaining the most accurate position information possible.

The *user segment* includes antennas, receivers, and processors that use the position and time signals broadcast from GPS satellites to calculate precise position, as well as speed, direction of travel, and time. Measurements collected simultaneously from three satellites provide accurate two-dimensional information, usually in terms of latitude and longitudinal positions. A minimum of four satellites providing measurements allows for three-dimensional information, latitude, longitude, and elevation above sea level. Database information contained in GPS receivers correlate this basic position information with referenced points in the database, such as airports, roads, and other landmarks of interest. GPS units with appropriate software technology have the ability to build, save, and navigate according to user-defined routes connected by points, known as *fixes* associated with position locations.

Surveillance

Knowing the position and intended path of aircraft relative to other aircraft, both on the ground and in the air, is necessary to ensure safe separation. The accuracy and certainty with which aircraft positions can be tracked determines the procedures and spacing allowed to maintain safe operations. Enhanced surveillance improves the efficiency of airspace usage by allowing reduced separation requirements, for example. In order to realize reduced separations standards, the free flight concept imposes particularly high demands on the ability to accurately and reliably locate and track the movement of aircraft with Separation has traditionally been ensured by visual confirmation, radar imaging, and pilot position reports. Visual separation is common in both general aviation and commercial operations, although its use is limited to fair weather conditions. Radar imaging allows air traffic controllers to see a wide view of air-greater precision and at a faster update rate than is used today.

Technology placed in aircraft cockpits, known as the **Traffic Alert and Collision Avoidance System (TCAS),** is currently being implemented in aircraft to provide the pilot with enhanced traffic surveillance information. Part of the TCAS capability is a display showing the pilot the relative positions and velocities of
aircraft up to 40 miles away. The instrument sounds an alarm when it determines that another aircraft

will pass too closely to the subject aircraft. TCAS provides a backup to the air traffic control system's regular separation processes.

To augment existing surveillance procedures and radar, the implementation of a new system known as **Automated Dependent Surveillance (ADS)** is under process. Unlike radar, which tracks aircraft by using interrogating radio signals, ADS transmits position reports on the basis of onboard navigational instruments.

ADS relies on data link technologies to transmit this information. Currently, there are two forms of ADS: ADS-Address (ADS-A) and ADS-Broadcast (ADS-B). The ADS-A system exchanges point-to-point information between a specific aircraft and an air traffic management facility, whereas the ADS-B system broadcasts information periodically to all aircraft and all air traffic management facilities within a specified area. The primary objective of ADS-A and ADS-B technology is to improve surveillance coverage, particularly in areas having poor or no radar coverage.

ADS-B will enable transmission of GPS position information, aircraft identification, altitude, velocity vector, and intent information. Airborne surveillance will be obtained using the Cockpit Display of Traffic information (CDTI) system that will show pilots the relative position and movement of ADS-equipped aircraft in their vicinity. Air traffic controllers will verify ADS positions by superimposing them over primary radar reports. In areas not covered by radar, ADS-B will allow separation requirements for participating aircraft to be reduced from current procedural separation standards, providing greater capacity and increasing the number of approvals for user-preferred altitudes.

4.14 Air Traffic Management

Managing air traffic and airspace utilization is becoming increasingly augmented with computer-based decision support systems. These systems are intended to improve the efficiency and effectiveness of NAS-wide information, enhancing all phases of surface and flight operations. The use of advanced automation and decision support systems is intended to enable the following capabilities:

- Greater collaboration on problem resolution through dynamic airspace management.
- More efficient use of airports through improved sequencing and spacing of arrival traffic and assigning aircraft to runways
- Improved acquisition and distribution of flight-specific data
- More information from static and dynamic data, such as route structures, NAS infrastructure states, special-use airspace restrictions, and aircraft position and trajectories
- Improved accommodation of user preferences through improved traffic flow management, conflict detection and resolution, sequencing, and optimal trajectories
- More flexible airspace structure by reducing boundary restrictions and creating dynamic sectors

Air traffic controllers currently use a combination of procedures and automated systems to separate traffic. Current decision-support systems technologies, however, provide only limited assistance to air traffic controllers. Most routine decisions are based on the training, experience, and judgment of the individual
controllers, who must follow a set of narrowly defined air traffic procedures. As the volume of air traffic increases and as procedures allow greater pilot discretion, the efficient management and monitoring of air traffic will require the use of more advanced decision-support systems.

Standard Terminal Automation Replacement System (STARS) and Display System Replacement (DSR) The **Standard Terminal Automation**
Replacement System (STARS) is a joint FAA and DOD program to replace Automated Radar Terminal

Systems (ARTS) and other capacity-constrained, older technology systems at 172 FAA and up to 199 DOD terminal radar approach control facilities and associated towers. STARS will be used by controllers to provide air traffic control services to aircraft in terminal areas. Typical terminal area ATC services include the separation and sequencing of air traffic, the provision of traffic alerts and weather advisories, and radar vectoring for departing and arriving traffic. The system will reduce the life cycle cost of ownership, accommodate air traffic growth, and provide for the introduction of new automation functions which improve the safety and efficiency of the National Airspace System. STARS will also provide safety functions such as conflict alert and minimum safe altitude warning. Improvements, such as better weather displays, will be introduced on the STARS platform to support air traffic management decision support functionality. STARS will also provide the platform for data link communications and Center-TRACON Automation Systems (CTAS) and Final Approach Spacing Tools (FAST). The STARS program is being managed under the FAA's Terminal Business Service (ATB). The STARS effort is led by a product team with members integrated from acquisition and operations organizations of the FAA and DOD. The team works collaboratively to ensure that STARS development benefits from the insights and experience of each member. The controller and technician unions are also contributing to STARS efforts.

Operational enhancements to ATC

A cost-efficient alternative to airport and airspace development is the modification and enhancement of current air traffic control operating procedures to improve the flow of aircraft within the NAS. Examples of initiatives in the en route air traffic environment are the **National Route Program (NRP)** and the **3D User-Preferred Trajectories Flight Trials Project,** both of which are intended to decrease restrictions on aircraft and allow pilots to fly more direct routes. In the oceanic environment, reduced horizontal and vertical separation standards are intended to provide more airspace availability and to provide pilots with more flexibility and efficient routing. Additionally, less-restrictive instrument approach procedures are being developed for the terminal environment as the accuracy of NAVAIDs used for approaches improves.

Reduced Vertical Separation Minima (RVSM)

The goal of RVSM (Reduced Vertical Separation Minima) is to reduce the vertical separation above flight level (FL) 290 from the current 2,000-foot minimum to a 1,000-foot minimum. This will allow aircraft to safely fly more optimum routes, gain fuel savings, and increase airspace capacity. The process of safely changing this separation standard requires a study to assess the actual performance of airspace users under the current separation (2,000 feet) and potential performance under the new standard (1,000 feet). In 1988, the ICAO Review of General Concept of Separation Panel (RGCSP) completed this study and concluded that safe implementation of the 1,000-foot separation standard was technically feasible. The U.S. Domestic RVSM Program is a key element of the FAA's National Airspace System (NAS) Operational Evolution Plan (OEP). The DRVSM program is listed in the OEP as an "Enroute Congestion" project. The objective of DRVSM is to implement RVSM in the airspace over the contiguous 48 states of the Full DRVSM will add six additional usable altitudes above flight level (FL) 290 to those available under today's Conventional Vertical Separation Minimum system. The ATC system will experience increased benefits, which have already been achieved in those oceanic areas wherein RVSM has become operational. The operational differences in domestic airspace, however, create challenges not experienced thus far in institutionalizing RVSM as an operational concept within the oceanic realm. The domestic U.S. airspace contains a wider variety of aircraft types, higher-density traffic, and an increased percentage of climbing and descending traffic. This, in conjunction with an intricate route structure with numerous major crossing points, ensures that it is a more demanding environment for the implementation of RVSM than that which has been experienced to this point (Fig. 4.5). United States and Alaska and in Gulf of Mexico airspace where the FAA provides air traffic services. The proposal to implement RVSM between FL 290–410 (inclusive) January 20, 2005 is considered to be a feasible option and the FAA is developing its plans accordingly. The goal of DRVSM is to achieve in domestic airspace those user and provider benefits inherent to operations conducted at more-optimum flight profiles and with increased airspace capacity.

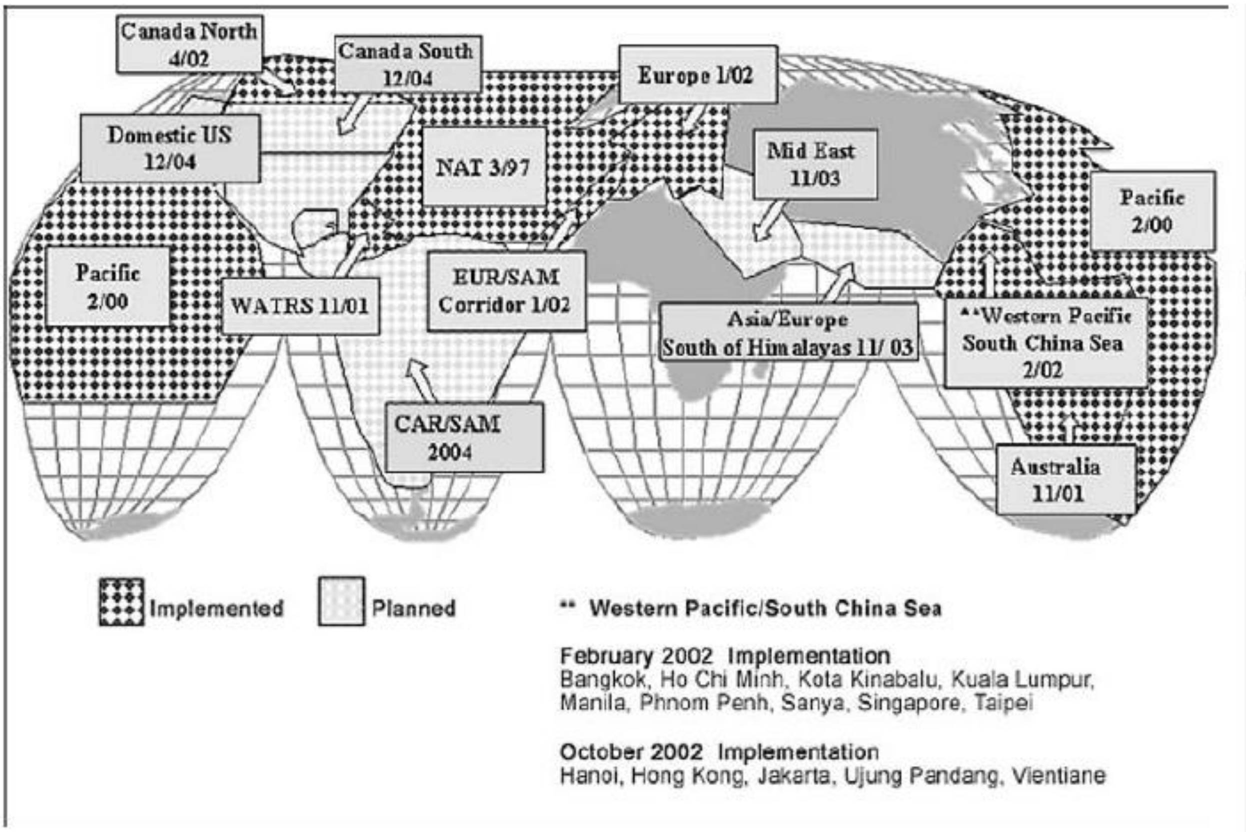

Fig 4.5 Planned implementation of RVSM.

Reduced Horizontal Separation Minima (RHSM)

In April 1998, oceanic lateral separation standards were reduced from 100 nautical miles (nm) to 50 nautical miles in the Anchorage airspace of the North Pacific. Longitudinal separation minima were also reduced in the North Pacific from the time-based standard of 15 minutes to 50 nautical miles. The FAA expanded the 50-nauticalmiles lateral and longitudinal separation standards to the Central Pacific airspace for all qualified aircraft in December 1998. By 2002, RHSM had been implemented on Central East Pacific Routes, as well. The timetable for RHSM includes 50-nautical-miles separation minima on all oceanic routes by 2004, and reduced lateral separation minima to 30 nautical miles by 2005. Prior to 2000, funding to meet the schedule for RHSM was minimal. The Wendell Ford Aviation Investment and Reform Act (AIR-21), however, allocated sufficient funding and prioritization to continue this efficiency-enhancing program.

4.15 Airport ground access

Access to the airport from the surrounding community is an integral part of the overall passenger and baggage processing system. The *access/egress link* of an airport's passenger handling system includes all of the ground transportation facilities, vehicles, and other modal transfer facilities required to move

the passenger to and from the airport. Included in the access/egress link are highways, intercity and metropolitan rail service, autos, taxicabs, buses, shuttles, limousines, and transfer stations, including off- and on-airport parking sites and rail
stations.

Airport access is usually divided into two major segments:

- Access from the **CBD (central business district)** and suburban areas via highway and rapid transit systems to the airport boundary
- Access from the airport boundary to parking areas and passenger unloading curbs at the terminal building

Access from the CBD and suburban areas to the airport boundary

The segment connecting the airport with the surrounding metropolitan area is a part of the overall regional or urban transportation system and serves general and airport traffic. State and local highway departments and local transit authorities bear the major responsibility for the administration, design, and construction of this segment. Airport management, however, is responsible for developing the requirements of airport traffic that must be served within this segment. They are also responsible for promoting the development of facilities to serve that demand. Regional, state, and local planning bodies, commonly known as **metropolitan planning organizations (MPOs),** are relied upon to bring together the general needs of urban transportation and the specialized needs of airports by the development of comprehensive transportation plans for metropolitan or regional areas as a whole. At the federal level, the Department of Transportation and the Department of Housing and Urban Development provide national inputs through programs such as the Federal Highway Grants-in-Aid Program, and urban transportation planning funds. With this diversification of responsibility, careful coordination is required if the first segment of the airport access problem is to be effectively resolved.

Access modes

Unless the ultimate destination of any travel itinerary is the airport itself, every trip on a commercial aircraft and nearly every trip on a general aviation aircraft includes an additional mode of transportation. A *mode* of transportation is defined as a type of vehicle used to travel from one point to another. The Transportation Research Board defines the most common modes of airport access as:

- *Private vehicles:* Vehicles used to transport airline passengers or visitors (e.g., family members, employees, friends, or clients), without payment of a fare by the passenger, which are privately owned and privately operated.
- *Rental cars:* Vehicles used to transport airline passengers or visitors, which are leased by the passenger or visitor from an agency doing business at or near the airport and rented for the duration of the passenger’s or visitor’s trip. Vehicles rented under a long-term lease (i.e., greater than 3 months) are considered private vehicles, not rental cars.
- *Courtesy vehicles:* Door-to-door, shared-ride transportation provided for customers of hotels, motels, rental car agencies, parking lots (both those privately operated and airport operated), and other services. Typically, no fare is charged because the transportation service is considered part of (or incidental to) the primary service being provided.
- *Airline crew vehicles:* Shared-ride transportation between airports and hotels provided at no charge for airline crew members by the employer. Service is provided using a variety of vehicles, including full size buses, minibuses, vans, and station wagons.

- *Taxicabs:* Privately operated door-to-door, on-demand, exclusive transportation (i.e., for a single party, typically up to five persons). Fares are typically calculated according to trip length and travel time using a taximeter and according to rates established by a city or county licensing agency (e.g., a taxicab commission or public services commission), but fares may be zone fares, flat fares (predetermined fares between certain points, such as the airport and downtown), or negotiated fares. Typically, the fare is for use of the entire vehicle, although some communities allow extra fares per passenger or piece of baggage.
- *Town cars (on-demand limousines):* Privately operated door-to-door, on-demand ground transportation services that typically charge premium fares calculated on a per-mile and per-hour basis, available at the curbsides of some airports. These exclusive transportation services are typically provided using luxury town cars or limousines.
- *Prearranged limousines:* Door-to-door services that provide exclusive transportation and require reservations. Fares may be flat, calculated on a per-hour basis, or negotiated, regardless of the number of persons transported, according to rates approved by local or state licensing agencies. Such agencies sometimes also specify the geographic area.
- *Shared-ride, door-to-door vans:* Shared-ride, door-to-door transportation services, which charge customers a predetermined flat fare per passenger or zone. Typically, transportation from the airport is on-demand, but transportation to the airport requires prior reservations. Vehicles may be licensed as shared-ride vans, airport transfer vans, or, in some communities, as taxicabs or prearranged/chartered vans. In most communities, the service is operated using radio-dispatched, eight-passenger vans, but station wagons, limousines, and sedans are also used.
- *Scheduled buses:* Scheduled service operating to established stops or terminals, typically on a scheduled basis, along a fixed route, which charges a predetermined flat fare per passenger or zone. In many communities, there are two classes of bus service:

4.16 Factors influencing demand for ground access

Demand for ground access, that is, the volume of people that wish to have access between the airport and their respective origins and destinations at commercial service airports, is primarily generated by the number of enplaning and deplaning passengers using the airport. These volumes are generated in part by the provision of air service by the air carriers that serve the airport. Characteristics of this air service include destinations served, the type of aircraft used, and the daily departure and arrival schedules of the air carriers. In addition to passengers themselves, airports are accessed by those people seeing off or meeting passengers at the airport. These people are known as *meeters/greeters*. The demand for airport access by meters/greeters is dependent on similar characteristics as that of passengers themselves. A significant proportion of trips made to and from airports are generated by the workforce in place at each airport, including airport, airline, and government employees, as well as employees of the many private companies that do business at the airport, including concessionaires, contractors, and suppliers. These trips are less dependent on available flight service. They are more associated with the travels that occur during any business day, including morning and evening commutes and trips associated with business delivery. In addition, as many functions in the airport operate as much as 24 hours per day, there are a number of trips to the airport that occur outside normal business hours.

Coordination and planning of ground access infrastructure

To effectively develop ground access requirements to the airport from the CBD and suburban areas, it is important to gain an understanding of the geographic region from which passengers access the airport.

This region is known as an airport's *capture area*. For commercial service airports, the geographic size of a capture area varies greatly, depending primarily on the population density in the region and the availability and cost of air carrier service from the airport, as well as from other airports within the region. General aviation airports typically serve more local areas, such as one CBD, suburban area, or outlying community. Many communities fall into multiple airport capture areas illustrating the fact that passengers in fact choose to access different airports from the same region on the basis of the characteristics of each airport, offered air service, and the ground access system.
Although not the most significant determinant of passenger volumes, the ability to access one airport over another indeed has an effect on which airport a passenger will choose to use. The ability of airport planners and managers to identify the airport's capture area and coordinate an effective ground access system from within the capture area to the airport is vital to the ultimate success of the airport.

Access from the airport boundary to parking areas and passenger unloading curbs at the terminal building

The second segment of airport access, from the airport boundary to the parking area and terminal building unloading curbs, is primarily the responsibility of airport management. This segment includes vehicle parking facilities, curb frontage at the terminal, intra-airport public transit systems such as shuttle buses or light rail systems, and vehicle roads that connect facilities existing on airport property.

Vehicle parking facilities

Parking facilities at or near the airport must be provided for passengers, visitors accompanying passengers, people employed at the airport, car rentals and limousines, and those doing business with airport tenants.
Public parking facilities are provided for airline passengers, meeters/greeters, and other members of the public doing business at the airport. Most commercial service airports have separate parking facilities for short-term and long term parking. Surveys at a number of major airports indicate that a large number (75 percent or more) park 3 hours or less and a much smaller group parks from 12 hours to several days or longer; however, short-term parkers, due to their relatively short parking durations, typically represent only about 20 percent of the total maximum vehicle accumulation. Consequently, many airports designate relatively few parking spaces to short-term parkers, typically the most convenient (closest area) spaces. Parking rates for short-term parking
are typically higher than that for longer-term parking. This rate strategy achieves two goals. First, it provides incentive for those intending to park their vehicles for a relatively long period of time to use long-term parking facilities, thereby leaving spaces available for short-term parkers in the closer, more convenient, short-term parking area. Second, it tends to maximize the amount of total revenue generated by the parking system to the airport (Fig. 4.6).
The events of September 11, 2001, have led to a recurring mandate by the federal government to prohibit public vehicle parking within 300 feet of airport terminals. This mandate was generated to minimize the threat of any vehicle loaded with explosives to detonate within close proximity of the airport terminal frontage. As a result of this mandate, many public parking facilities were required to close significant proportions of their available parking spaces, primarily those in the higher-revenue-generating short-term facilities. Because of the irregular implementation of this mandate, little has been done to implement long-term strategies to effectively manage public vehicle parking during these periods of restriction.

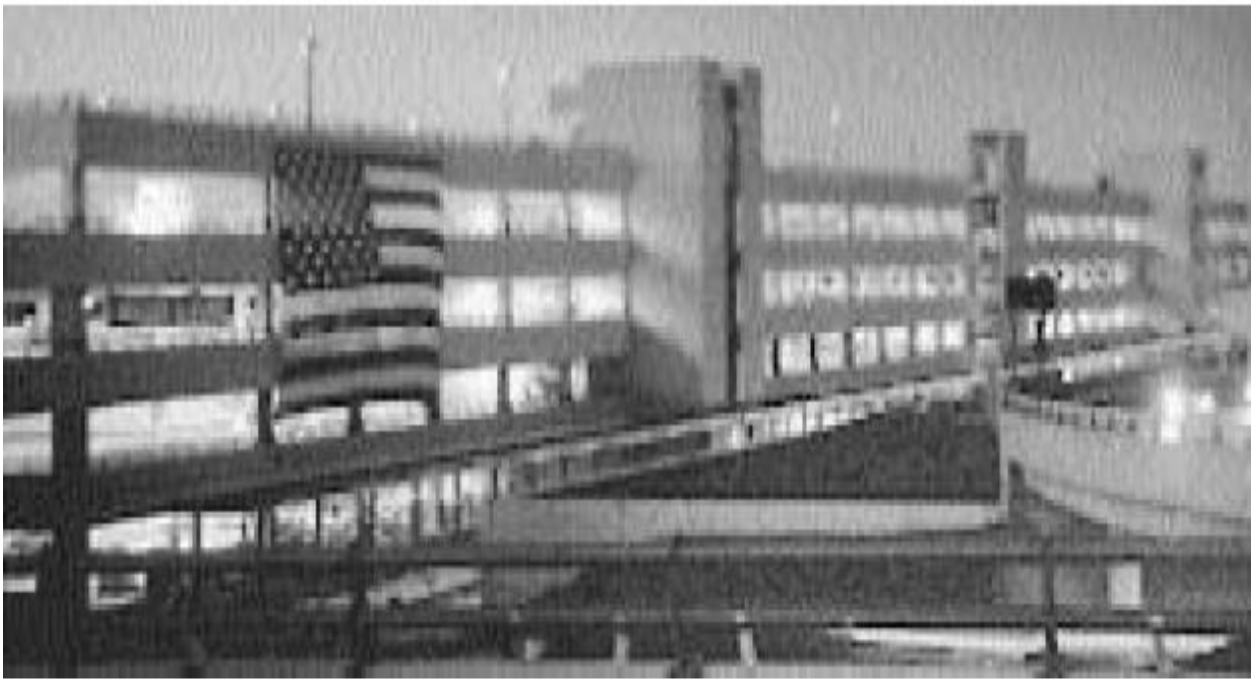

Fig. 4.6 New multilevel parking garage at Washington Dulles International Airport

Off-airport parking

Recent years have seen an increase in the number of public airport parking facilities located off-airport property and operated by independent private operators. These facilities typically offer parking at lower rates than airport-operated facilities. Although they tend to be located farther away from the airport terminal, frequent shuttle service between the parking facility and the terminal often offsets the extra distance. In addition, some off-airport parking facilities offer extra amenities ranging from free coffee and newspapers for customers, to automobile washes and valet service. The success of off-airport parking facilities can have a direct, significant effect on airport revenues, because these facilities do not pay any portion of their revenue to the airport.

Terminal curbs

The terminal curb front provides temporary vehicle storage during passengers' transition between the terminal and the landside, and it is at the curbside that all passengers, except those using nearby parking or transit facilities, either enter or leave some form of ground transportation. A variety of pedestrians, private automobiles, taxis, buses, commercial delivery trucks, and shuttle vans use the terminal curb area. At the terminal curb, passengers might be carrying luggage to or from the terminal building, checking luggage at curbside facilities, and waiting for access to taxis or other vehicles. At some airports, passengers must cross frontage roads to reach parking areas from the terminal curb. The primary determinants in the amount of curb frontage space required at a terminal are the number of vehicles that arrive to the curb over a given period of time, the types of vehicles that use the curb, and the length of time that vehicles stop for loading and unloading, referred to as the dwell time. Dwell times of vehicles range from a little as 1 minute for private vehicles and taxicabs dropping off passengers, to greater than 5 minutes for shuttle vans and buses waiting for arriving passengers to transport to their ultimate destinations on the landside.

Because private automobiles are the dominant ground access mode at most airports, they are the principal source of terminal curb frontage demand. Such demand can be reduced at some airports by increasing availability of convenient parking, which typically raises the proportion of motorists who enter or exit parking areas directly without stopping at the curb frontage, or by encouraging passengers to use off-airport check-in facilities if these are available. Demand for curb frontage is also determined by flight schedules and particularly by the arrival pattern of originating passengers (how far in advance of the scheduled departure time they arrive at the airport) and the route through the terminal of terminating passengers (how long it takes them to travel from an arriving flight to the curb). Type of flight and trip purpose also influenced by terminal curb demand. For example, originating passengers on international flights are requested to arrive at the airport earlier than those aboard domestic flights. Terminating international passengers also typically take more time than domestic passengers to reach the curb frontage because of required customs and immigration procedures.

Technologies to improve ground access to airports

A variety of technologies are in development and implementation to improve both segments of airport ground access, including advanced traveler information systems (ATIS); emerging bus, rail, and automated people mover technologies; as well as alternative strategies for off-site airport check-in. Advanced traveler information systems allow travelers to better estimate the travel time to the airport and in some cases offer the passenger alternative routes or modes that may offer reduced travel time or monetary cost of travel.

Much of this information is gathered from real-time monitoring of traffic volumes on major access roads, and operational status of public transit systems (Figs. 4.7 and 4.8). Advanced traveler information systems may also be used to improve the performance of public parking facilities by providing information to travelers regarding specific locations where spaces within parking facilities are available (Fig. 6-30). The implementation of latest-generation public transportation systems connecting airports with regional transportation centers seeks to improve ground access to airports by providing convenient access to airports using the existing public transportation infrastructure and reducing the demand of private and private-hire automobile traffic on the surrounding road systems (Fig. 4.9). Although fundamental operational and planning concepts apply to every airport terminal facility, there are no two airport terminals in the world that are exactly alike. As a result, specific understanding of the operations of a particular airport terminal facility is necessary to operate and plan for the goal of accommodating both passengers and aircraft in the most efficient and high-quality manner.

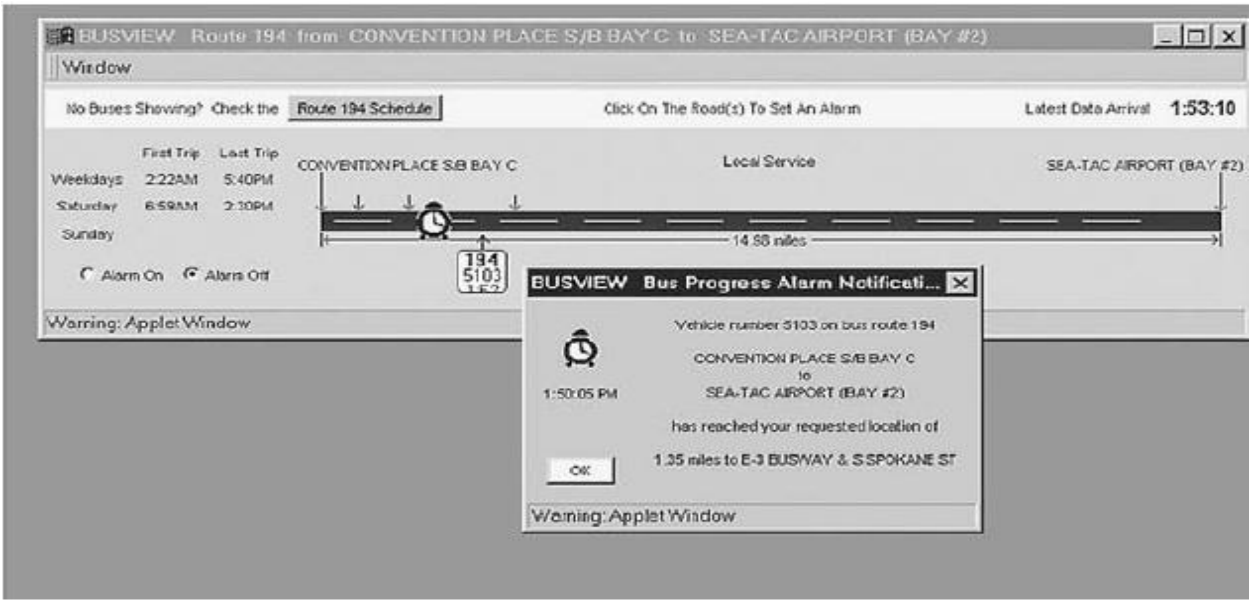

Fig 4.7 Real-time information regarding the status of public buses serving the airport

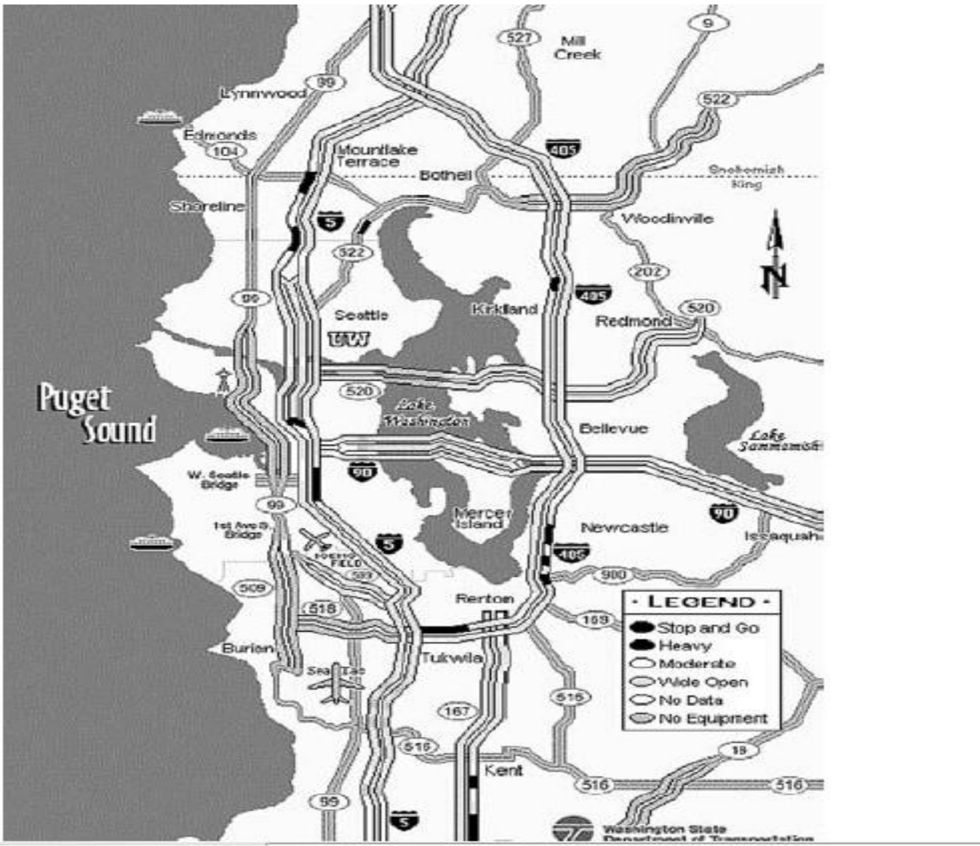

Fig 4.8 *Real-time traffic conditions broadcast over the Internet provide useful information for travelers accessing airports.*

UNIT-V
OPERATIONAL ADMINISTRATION AND PERFORMANCE

5.1 Airport performance measurement

Airport performance measurement is a critical management activity at both the individual airport and the wider system levels. Airport managers and governments measure airport performance for three main purposes: to measure financial and operational efficiency, to evaluate alternative investment strategies, and to allow governments to regulate airport activity (Doganis, 1992). A further purpose is to make publicly owned airports accountable to government. Airport managers need to have information to enable them to monitor performance and to identify areas that are performing well and those that are not. Once performance is known, management can examine the underlying processes taking place so that appropriate corrective action can be proposed. Government departments may use certain measures to monitor the management of a publicly owned airport or to regulate the activity of a privately owned airport.

Airports are complex and dynamic organizations that consist of many interacting parts, which include passengers, airlines, handling agents, ground transportation service providers, other aviation-related activity, and the interests of the regional and national economy. The range of different performance measurements reflects this complex nature. There has been a tendency to search for measures to simplify airport performance so that league tables can be drawn up and comparisons made. However, in simplifying the indicator, the meaning and therefore the usefulness to management or government disappear.

There is a tendency to use measures that are easy to monitor as opposed to what is important to measure: “Simple measures that do not shed any useful light on policy issues of concern are worse than no measures at all. They establish the pretence of measuring performance without actually doing so.” (Gosling, 2000, p. 15) Different performance measures are used for many different purposes by a variety of stakeholders in the airport context. Broadly speaking, performance measures can be divided into three main categories: business, service, and environmental.

Business measures are used largely to assess the performance of airports in terms of financial outcomes; these are usually quantitative in nature. Service measures consider airport operations from a qualitative and quantitative perspective. Environmental measures address the external impact of airport operations on the ecosystem.

5.2 Business Measures

Business Measures In the air transport industry, the use of performance indicators has been led by airline management with well-established industry measures, such as cost per available seat kilometer, yield per revenue passenger kilometer, and labor productivity per available tonne kilometer (Caves, Christensen, &Treathaway, 1983; Doganis, 1992). Research into the measurement of airport performance from a management perspective has been led by Doganis and Graham who, over the past 20 years or so, have produced a series of studies that focus on business performance indicators (Cranfield University, 1995; Doganis, 1978, 1983, 1992; Doganis& Graham, 1987; Graham, 1991, 1999). The work load unit (WLU) is a performance measure used by management at 13 of the 15 European airports interviewed. This measure can be defined as one passenger processed or 100.

Various operational services found at air carrier airports and be conveniently grouped together under this general heading. They are concerned with the safety of aircraft operations in terms of control, navigation and communications, and information.

Safety Management System

Airports Council International (ACI) agreed with the principle of certification in accordance with ICAO standards, but stated that "in the context of the ICAO program of safety audits for airports, Recommended Practices, for airport design should not become 'de-facto' Standards for airport operation, since they do not have same status as Standards, may be difficult to apply to existing airports (notably those concerned with airfield dimensions), and are not based on a defined and consistently-applied 'target level of safety".

Fundamental Changes

Air traffic control (ATC) capability was already under scrutiny in the 1970s, in that it was questionable that existing paradigms could ever provide capacity that would be consistent with demand. The concern was both in terms of peak movement capacity and the minimization of environmental impact. The latter has become increasingly relevant over subsequent time.

In 1983, ICAO established a special committee on the future air navigation system (FANS), and while the name implied that it terms of reference were limited to the navigation function, it was charged with developing very wide-ranging operational concepts for ATC.

The newer-generation systems have since evolved under the title air traffic management (ATM). The FANS report was published in 1988 and laid the basis for the industry's future strategy for ATM through digital communication, navigation, and surveillance (CNS) using satellites and data links.

5.3 Function of ATC

The primary purpose of ATC is the prevention of collisions between aircraft in flight and also between aircraft and any obstructions either moving or stationary on an airport. Additionally, it is concerned with promoting an efficient flow of air traffic. Efficient flow has tended to mean using up to the maximum capacity available in airspace, accepting that as the capacity limit is approached there will be an increasing level of delay.

International ATC Collaboration

These hasbeen considerable change over time in the way that the air traffic service function has been viewed internationally. Whereas it was always a "national" service, the advantage of imposing pan national service-quality attributes has been long recognized. In Europe in 1960, Euro control was formed as a unit funded by national governments to address the fundamental operational issue of the control of aircraft in the physically restricted volume of airspace over Belgium, the Netherlands, and Luxembourg (Benelux countries).

This resulted in the successful establishment of an ARTCC at Maastricht, in the Netherlands, that had control authority over the Benelux region and the upper airspace regions of northern Germany (at that time the Federal Republic of Germany (West Germany).] An attempt to spread the application of this philosophy at Karlsruhe, in southern Germany, was not as successful, and this ARTCC was later placed into German ownership.

5.4 Meteorology

Function

Aviation meteorological services are provided by governmental organizations in all ICAO Member States, and their services are organized to conform with ICAO Annex 3. Some countries employ their military to produce aviation-related weather products, but most use the civil meteorological organization.

World Area Forecast System

The World Area Forecast System was established by ICAO and the world Meteorological Organization (WMO) in 1982 with the purpose of providing worldwide aeronautical forecasts in a standardized form. The main task of the WAFCs is to provide significant weather forecasts as well as upper-air forecasts (grid-point forecasts) in digital form and on a global basis.

Meteorologic Observations and Reports

Meteorologic observations are vital to forecasting, and reports are generated by meteorological services worldwide. In context with aviation four types of routine observations of surface weather have been established by ICAO and are produced in either hourly or half-hourly intervals at many airports and partly at other geographically relevant sites.

- Aviation routine weather report (METAR)
- Aviation selected special weather report(SPECI)
- Local routine met report (met report)
- Local special met report (special)

METAR and SPECI

The METAR is the most common surface weather report for aviation purposes
Usually METARs are disseminated at half-hour intervals, although some stations only produce METARs hourly.

The METAR includes the following data:

- Station identification and time of observation
- Surface wind direction and speed (direction in true north)
- Visibility
- Runway visual range (RVR) when appropriate and available
- Present weather
- Cloud amount and type [only cumulonimbus and towering cumulus (CB and TCU)]
- Temperature and dew point
- QNH or atmospheric pressure above mean sea level (a MSL)
- Supplementary information
- Trend forecast

- Remarks when applicable (national dissemination only)

Aircraft observations and Reports

Meteorologic data obtained from aircraft in flight provide valuable information about weather conditions in places where either no surface or upper-air observations are available or no observation is possible.

Pilot Reports (PIREPs)

The pilot report is a weather observation by an air crew relayed to ATC via either voice communications or ACARS data link. It contains the following elements.

- Message identifier (UA or UUA) for routine or urgent messages.
- Position and flight level of the observing aircraft
- Time of report
- Aircraft type (important for reports on icing or turbulence)

Possible weather data include

- Wind direction and speed [(true north or magnetic north (United States)]
- Cloud cover
- Icing (light, moderate, or severe)
- Turbulence (light, moderate, or severe)
- Temperature
- Visibility
- Remarks

5.5 Significant Weather Forecasts and Charts

Significant weather forecasts (SIGWXs) and charts (SWCs) as well as upper-air forecast charts are generated and disseminated by the world area forecast centers (WAFCs) in London and Washington. They are then produced and locally distributed by the national meteorology authorities. Where local distribution is not available, the charts provided by the WAFCs are usually used.

The complexities of civil aviation are such that it is almost impossible to conduct a flight of any kind, even a short GA flight, without having recourse to considerable amount of aeronautical information such as ATC requirements (including airspace restrictions), airport layout, hours of operation, and availability of fuel.
These specify that an aeronautical information service is responsible under international agreement for

- The preparation of an aeronautical information publication (AIP)
- The origination of NOTAMs
- The origination of aeronautical information circulars (AICs)

Urgent Operational Information

NOTAMs are urgent notices for the attention of flight crews and operations personnel.

NOTAMs are distributed electronically. This replaces the previously used methods of teleprinter or fax, and while these are still the media used in remote areas, most nowadays will get very rapid electronic dissemination worldwide.

5.6 Access as part of the Airport System

Few years ago, It was customary for airport operators to consider that the problem of getting to the airport was chiefly the concern of the urban or regional transportation planner and the surface transport operators.

Congestion and difficulties in accessing airports have, as will be seen, very strong implications on their operations. Therefore, the airport administrator has an unavoidable vital interest in the whole area of access and accessibility, perhaps one of the most difficult problem areas to face airport management.
Figure below is a conceptualized diagram indicating how potential outbound passengers and freight traffic

Through an airport will be subject to capacity constraints at the various points in the system; a similar chain operates in reverse for inbound traffic.

Lack of access capacity is far from being a hypothetical occurrence. Several of the world's major airports already face severe capacity constraints in the access phase of throughput. Using direct traffic-estimation methods, urban transport planners can show that some of the most severe access problems can occur at airports set in the environment of large metropolitan areas, if these airports depend largely on road access.

5.7 EUROPEAN EXPERIENCE: GROWTH OF RETAIL MEASURES

The trend toward commercial airport operation in Europe has given performance measurement an increased significance and, in many senses, a new purpose. Business measures have assumed increased importance as managers, shareholders, and prospective buyers seek to assess performance. In particular, the commercial emphasis at airports has led to the development of a range of retail and property-related performance measures.

Interviews revealed typical measures found at the major European hub airports that make up the FLAP Group (Frankfurt, London, Amsterdam, and Paris airports) include concession income per passenger, commercial income per passenger, duty- and tax-free income per international departure passenger, property income per passenger, and property income per WLU. Revenue-based measures, such as traffic income per WLU, traffic income per passenger, and traffic income per turnover (in percentages) are still frequently used at airports across the airports surveyed in Europe.

However, these do not tell the airport manager how profitable an activity is. A large revenue stream may not necessarily generate large profits and could occupy terminal space, which might be more productively used. Interviews with several European airports suggested that the pursuit of revenue-based targets has affected the amount of retail floor space allocated to high-revenue earning businesses despite cases where these activities have.

Access users and modal choice

Airport passengers often, but not always, constitute the majority of persons entering or leaving an airport. Excluding individuals making trips as suppliers to the airport, the airport population can be divided into three categories.

- Passengers-originating, destined, transit and transfer.
- Employees-airline, airport, government, concessionaires and such
- Visitors-greeters, senders, sightseers, and such

The transit and transfer passengers make use of the access system. There is no single figure for the division of the airport population among these categories. Among airports and depends on such factors as the size of the airport; and the type of air service supplied. Large airports with large base airline fleets have extensive maintenance and engineering facilities.

Over the past 50 years, a number of superficial solutions have been proposed for the access problem, many of which have involved the use of some dedicated high-speed tracked technology to link the airport with the city center in an effort to reduce the demonstrated dominance of the automobile.

Consequently, the airport traveler competes with the urban dweller for road space and transit capacity during peak-hour periods. The passenger using the automobile, taxi, and bus, this means delay through congestion; for those using urban and intercity rail systems, it means possible difficulties in finding seats and handling baggage in crowded facilities.

Rail has been used successfully in connecting two major new European airports, Munich and Oslo.

The rail connection of Changi Singapore to the Singapore rail network is also a significant success, but the length of the network is necessarily small in the island republic.

Experiences in Europe of connecting directly into the high-speed rail (HSR) systems have shown varied success even in the same country.

Access Interaction with Passenger Terminal Operation

The method of operation of the passenger terminal and some of the associated problems of terminal operation depend partly on access in as much as this can affect the amount of time that the departing passenger spends in the terminal. it is the departing passenger who places most demands on the airport terminal system. Departing dwell times depend chiefly on the length of access time, reliability of access time, check-in and security search requirements, airline procedures, and the consequences of missing a flight.

Length of Access Time

It is likely that the amount of time for a particular access journey is a random variable that is normally distributed about its mean value. The variance of the individual journey time about the mean is in some way proportional to the mean.

Reliability of Access Trip

The effect of reliability on departing terminal dwell times is shown in Figure 13.4 if these are two access trips each with the same mean trip time of but with standard deviations of tandt, it can be seen that the mean terminal dwell time, under assumptions of normality and 99.5 percent arrivals by K minutes before STD, are t and respectively.

Check-in Procedures

Check-in requirements are not the same for all flights. For many long distance international flights, check-in times are a minimum of one hour before scheduled time of departure, whereas for domestic and short-haul international flights, this is usually cut to 30 minutes. With long-haul passengers spending an average of 22 more minutes in the terminal than short-haul passengers.
Similar differences are often observed between check-in procedures for chartered and scheduled passengers. The effect of longer closeout times is to increase passenger dwell time in the terminal prior to departure.

Consequences of Missing a Flight

Depending on the type of flight and the type of ticket, the passenger will have a very different attitude toward arriving after the flight has closed out and consequently missing the aircraft. This can be exemplified by considering a hypothetical trip maker making three different flights from Tampa international Airport. The first flight is on a normal scheduled ticket at full fare to Milami; the second is on a normal scheduled full-fare ticket to Buenous Aires; and the third is a special chartered holiday flight to London.

Fig 5.1 Winter airport operations

The implications of missing the three flights are not at all the same. Should the passenger miss the first flight, there will soon be another flight, and there is no financial loss. In the case of the second flight, the ticket remains valid, but because the connections will now be lost and there might not be an alternative flight rapidly available, there is serious inconvenience and maybe some financial loss.

Missing the third flight, however, Could cause much inconvenience through a spoiled holiday and serious financial los because the ticket is no longer valid. The passenger therefore will arrange his or her arrival at the airport in such a way that the risk of missing each flight is different.

In the arrival patterns at individual airports are a mixture of all these factors. The variation between arrival times can be seen in figure 13.8, which shows the cumulative arrival curves for four European airports. Its access times were reasonably predictable, and most flights were short haul.

Research examining the effect of the length and reliability of access times has confirmed that unreliable access times can cause congestion in the check-in area and long dwell times in the departure lounges.

The manner in which access is provided to the passenger becomes critical to the operation of airport terminals at many vacation locations. Airports such as Punta Cana in the Dominican Republic and Palma, Majorca, have large landside deliveries of passengers at times that have little to do with the scheduled time of departure of their flights. It is not uncommon for departing passengers to be delivered, by fleets of charter buses, to the departures area several hours before the scheduled time of departure, even before the check-in desks and baggage-drop facilities are open for their flights.

Access Modes

In most developed countries, the private car is the principal method of accessing airports. Since the inception of commercial air transport and the situation seems most unlikely to change in the foreseeable future. Airports must integrate a substantial parking capability into their design and operation.

As airports grow in size, it becomes difficult to provide adequate parking space within reasonable walking distance of the terminals. In the case of centralized operations, it is common to divide the parking areas into short-term facilities close to the terminal and both medium-and long-term parking areas often served by shuttle services.

Serious internal circulation congestion can limit the airport’s capacity if too many cars attempt to enter the facilities close to the terminal, a condition that has caused problems with the operation of the Terminal 1 at Paris Charles de Galle airport, where parking is integral to the terminal, and access is via a tunnel under the apron.

Major airports relying overwhelmingly on the automobile as the major access mode find that it is not solely in the matter of supplying and operating car parking that this decision materially affects the operation of the passenger terminal. The first solution leads to highly decentralized passenger terminal complex with possible difficulties in interlining, especially for baggage-laden international passengers. The second solution almost certainly will lead to the segregation of departing and arriving passenger flows throughout the terminal building.

For the air traveler, the taxi is perhaps the ideal method of accessing the airport from all aspects except one-cost. In general, this mode involves the least difficulty with baggage, is highly reliable, operates from a real origin or destination, and provides access directly to the airport curbside.The airport has an interest in maintaining a reasonable balance of supply and demand of taxis at the airport.

Many airports do not permit taxis to pick up a fare on airport property without a special license, for which the taxi operator must pay annually. In the United Kingdom, it is recent common practice for taxis to incur a charge for both a drop-off and a pickup an airport. As airports become large, it is not unusual that they suffer from too many cruising taxis, which cause congestion on the terminal access roads.

Limousine services, which are reasonably common in the United States and number of other countries, are either minibuses or large automobiles that provide connection between the airport and a number of designated centers (usually hotels) in the city.

In small cities, the limousine usually operates to only one central location; in larger cities, to designated multiple locations.

Operationally, a limousine is similar to a bus, and where bus services are feasible, it is unusual to have limousines as well. The contracts are lucrative to the limousine operator because passenger load factors are high, and therefore, the concessionary fees that go to the airport operator can be high in comparison with the cost of providing facilities. Because limousines are in fact a form of public transport, they relieve road congestion and the need for parking.

In the last 20 years, there has been a great deal of activity at large airports to move in the direction of providing more access by rail (TRB 2000,2002). Airports are widely spread across the globe as Chicago O'Hare, JFK, London Heathrow, Hong Kong, Beijing, Singapore, and Seoul Incheon are just some of the airports that have added rail access routes. The rail access facilities fall into three categories.

Provision of a connection into an existing rail rapid-transit system for example, Atlanta, Chicago O'Hare, Ronald Reagan Washington National, Paris Charles de Gaulle, and London Heathrow.

Direct connection to an existing national intercity rail network-for example, Zurich Kloten, Schiphol Amsterdam, Franfurt, London Gatwick, and Brussels.

Dedicated link from airport to city center location or locations-for example, Munich, Oslo, Beijing, Inchon, and Shanghai.

If rail services is to be successful for all three rail modes (i.e., urban rapid transit, conventional intercity rail, and dedicated links), it requires a compact connection at the airport end.

The access rail system and any system to which it connects must be able to accommodate storing of luggage on the trip.

Access time, provided that it is reasonable for the distance covered, is not extremely important to passengers, so the cost of supplying very high speeds may not be worth striving for.

Access journey time does not appear to be critical to air travelers, except in the very shortest hauls with competitive surface modes. The selection of an access mode is much more affected by the ability to cope with inconvenient and heavy baggage and the total cost to the traveling party.

Around the world, virtually all airports carrying reasonable volumes of passengers by scheduled and charter operators are connected by bus to the city center. Normally this is arranged by contract between the bus operator and the airport authority whereby the bus company usually pays the airport a concessionary fee or percentage for the exclusive right to provide an agreed-on scheduled service. Service is supplied to a number of point in large cities but perhaps to only one point in a small urban area.

Buses become extremely important at airports serving many resorts. Bus loading and unloading areas are designated and must be kept clear of taxis and automobiles. Bus parks are as important as car parks, and the airport operator has an interest in ensuring that the bus parks are kept operational and clear.

In the area of airport access, nothing has caught the public imagination more than the concept of some form of futuristic high-speed, tracked vehicle that will convey passengers from the airport to the town center unimpeded by surface-road or rail traffic. High-speed tracked airport-access vehicles on dedicated rights-of-way are unlikely to be built anywhere in the world where the economics of access costs are correctly considered. High-speed links are unnecessary, save little time over trains operating nonstop at conventional speeds, are likely to cost half as much as the remote airport they purport to serve, and can move passengers only to and from the central city, where most travelers probably have no wish to go.

More-over, if they require public subsidy, they raise an ethical question as to whether the air traveler has any right to expect to travel to the urban area at a higher speed than any other traveler. Even so, it is likely that they will continue to receive a disproportionate amount of public and media interest.

In-Town and Other Off-Airport Terminals

Experience with in-town terminals with check-in facilities has been varied. Originally opened in 1957, when the West London Terminal serving Heathrow was closed, only 10 percent of passengers were using the facility. As well as being uneconomic, it was difficult to have reliable connections between the off-airport terminal and the airport owing to increasing road congestion on the airport access routes. Examples of successful in-town airline bus terminals with no check-in facilities are more numerous.
Because of the availability of online ticketing and online check-in, there has been little recent development in remote check-in by the airlines. Attractive service can perform poorly if the convenience level of the traveler is debased by long walking distances with baggage, frequent changes of level by stairs, crowded vehicles, and inadequate stowage space.

Service Measures In addition to business measures, managers, regulators, and government bodies need to measure the service performance of airports. Service measures are used to assess the day-to-day service quality delivered by the different parts of an airport to its users. Short- and long-term summaries of this information provide a vital input to airport management. Service measures are particularly useful for identifying operational problems. Regulators and government bodies use selected summaries of airport service measures to monitor airport performance to check that the interests of the users are not being compromised and to provide input into airport planning decisions.

Service measures based on the subjective perception of service quality by airport users are collected through surveys in which respondents are asked to grade their experience on a 5-point scale. Common measures included overall customer satisfaction at the airport, signage/user friendliness of terminal, cleanliness of terminal, cleanliness of restrooms, check-in satisfaction, catering overall satisfaction, value for money in the shops, baggage delivery overall satisfaction.

5.8 Factors Affecting Access-Mode Choice

The level of traffic attracted to any access mode is function of the traveler's perception of three main classes of variables:

- Cost
- Comfort
- Convenience

Decisions in terms of these variables are made not only on the level of service provided by a particular mode but also on the comparative level of service offered by competing access modes.

Transportation planners have numerous models ranging from the simple to the complex to explain the modal selection procedure.

Environmental Measures Environmental performance measures are required to monitor the impact of the airport operation on the adjacent environment. Aircraft noise (number of homes within a certain noise contour averaged over a 16-hour working day), surface access (percentage of passenger trips on public transport), and waste produced (kilograms per passenger) are the most common airport impacts that are measured. Governments and local planning authorities use environmental performance measures to maintain a degree of control over the external environmental effects of aviation within the airport boundary and beyond it.

Airport management uses these measures to monitor the impact of the airport and the compliance of its users to operating standards with respect to environmental implications. Airport expansion in Europe has given rise to a new, comprehensive range of environmental performance measures far beyond the traditional noise-based agreements. Environmental targets are often put in place as a condition of allowing airports to expand, as a means of maintaining environmental protection for the community. There are few major European airports that do not have some form of environmental restrictions placed on how they operate. Beyond measures related to aircraft noise, performance measures used vary from airport to airport to reflect the particular environmental concerns associated with a particular airport context. An interesting example of a comprehensive range of such measures is illustrated by Manchester Airport, which became one of the few European airports to receive permission for the building of a second runway in the past 30 years, partly because it proposed 34 environmental key performance targets on which they would be externally monitored and reported on each year. The measures applied here were seen to be significant by a number of the airports interviewed because they set a standard that other developments may have to at least match. The establishment of environmental targets to protect the community around an airport may promote dysfunctional effects.

Interview evidence from a European airport revealed that targets to achieve a certain percentage of ground access trips to the airport by public transport modes had led to the relocation of the car parks to a site outside the airport boundary. Passengers park and catch a courtesy bus into the terminal area, and these trips are counted as public transport modes. This is clearly a way of meeting the targets without achieving the operational shift in activity that the performance measure was supposed to induce—an increase in the level of public transport access to airports.
Performance measures need monitoring to check against these dysfunctional effects so that any issues can be identified and the performance measures adapted.

5.9 Toward a Contingency Approach to Understanding the Context of Airport Performance Measurement

"An airport is not an airport is not an airport." There is often the significant failure to recognize this underlying context with existing performance measures. Airports serve vastly different passenger types, all of whom have different needs and wants, which in turn impose a range of different demands on the airport's resources. A normative framework is required to assess the specific characteristics of each airport. Passengers make a variety of different demands on the capacity offered by an airport, which in turn generate a varied range of different revenues.

The differences need to be accounted for and measures of performance calculated with respect to different traffic segments. Once this has been achieved, then more meaningful interairport comparisons of performance may be possible, given consideration of the full range of contingent variables. This normalization opens the way for developing and overcoming some of the previous barriers to benchmarking (see Francis et al., 1999). It is inappropriate to consider outputs alone; the wider outcomes should also be considered. Smith (1993) describes the differences in the measurement of outcomes as opposed to outputs and discusses the associated problems.

Similarly, performance measures should not be considered in isolation from their context. One manager interviewed commented, "Measures are no use if they are considered in isolation". This is an increased danger with the automatic collection of data, which is meaningless without considering the context. One way of evaluating a performance measurement system could be through contingency theory (see Lawrence &Lorsch, 1969; Marchant, 1984). Otley (1980) suggested a contingency framework that identified the following influences in organizations: contingent variables, organizational control networks, intervening variables, and end result variables. These factors are interrelated and begin with the contingent variables, which interplay with organizational control networks and intervening variables (which are associated with the people who make up the organization).

End result variables represent the outcomes (or outputs) that measure the performance of the organization. Elnathan, Lin, and Young (1996) discuss a suitable framework for research, which could be adapted. Contingent variables listed in Figure 1 will shape the nature and level of airport performance in certain ways that may profoundly influence inter airport comparisons. The performance of airports needs to be explained in the context of each airport's operating characteristics.
This does not necessitate against a common set of measures but against a common set of standards against which performance is compared. The contingent factors identified are not independent of each other; they are interrelated, as the following discussion will reveal.

5.10 AIRPORT PERFORMANCE

Systematic monitoring and comparing of airport economic performance has been practised more widely from 1980`s. Until that airports weren`t under commercial or business pressure and benchmarking as study techniques within public sector was suffering the lack of experience. It was difficult to make meaningful comparisons because of varying involvement in airport activities and different accounting policies. With airport commercialization and privatization has come a marked interest in performance comparisons and benchmarking. As airports have become more commercially oriented, they have been keen to identify the strong performers in the industry and adopt what are seen as best practices.

Investors and bankers, who are traditionally much more used to using financial ratios and other benchmarking techniques, are interested to identify possible business opportunities and to ensure their chosen airport investment continues to perform well. Airlines, which are now operating in a much more cost conscious and competitive environment, have an interest in identifying those airports that are being inefficiently managed, because they are lobbying against increases in user charges. Economic regulators of privatized or autonomously managed airports also have good reason to monitor airport performance to ensure users are being charged fairly and that the airports are run efficiently.

Local communities may also be interested to ensure that the airport is being run in an efficient manner so that they can benefit fully from the economic benefits, such as tourism and inward investment that the airport can bring. In this, the theoretical framework of the study is introduced and the reasons behind choosing benchmarking as technique for analyzing the collected data is justified. Best Practice Benchmarking as a tool is introduced as well as performance indicators for airports. Justifications for City of Mikkeli why Best Practice Benchmarking can be used when analyzing the performance of an airport using input–output ratios for improving the performance of Mikkeli City airport are presented.

5.11 Performance management techniques for airports

Studies about airport performance management techniques used by top busiest passenger airports have been done for instance by Francis et al. and Fry et al. According to studies of Francis et al., from respondents 46% agreed that when their organizations are seeking possibilities for improving their performance the most popular technique used by airports was best practice benchmarking.
According to ACI Europe, airport benchmarking is divided into two types of comparisons:

1) Internal (or self benchmarking), where an airport compares its performance with itself over time;

2) External (or peer benchmarking), where an airport compares its performance against other airports, either at a single point in time or over a period of time.

The idea behind the Best Practice Benchmarking is to search outside of the organization for best practice to gain competitive advantage. Total Quality Management (TQM) was also popular among the respondents (41%). The technique is used for improving airport performance quality. For the same purpose are used the Quality Management System (23%), Business Excellence Model (12%) and Malcolm Baldridge Award (5%). Activity Based Costing (36%) is used for improving and understanding the cost structure and resource utilization of an airport. Value Based Management tries to measure financial performance in terms of the creation value for shareholders (9%).

Balanced Scorecard (%) tries to create a balance between a range of financial and non-financial performance criteria. According to the respondents 95% had used data collection surveys, 25% interviews and 20% consultants. The response rate was 32% from 195 questionnaires from the top 200 busiest passenger airports as ranked by ACI in terms of total passengers for 1999. Geographically, 48% were from North America, 38% from Europe, 5% from Pacific, 5% from Asia, 2% from Latin America/Caribbean and 2% from Africa.

From these airports 29% were handling 1–4 million passengers, 24% from 5 to 9 million passengers, 23% from 10 to 19 million passengers and 24% from 20 and above million passengers. 67% of the airports were publicly owned, 19% privately and 14% Part privately–part publicly owned.

5.12 Performance Indicators for airports

The airport industry is very diverse and heterogeneous with a high degree of quality differentiation, different ownership and regulatory structures, different mixes of services and operating characteristics, as well as external constraints such as location and environmental factors. Because of these reasons, measuring and comparing the performance of airports is difficult. The task is even more challenging when the best practice benchmarking is done between successful international airport as Stockholm Skavsta airport and small Finnish regional airport, Mikkeli City airport, which is just at the start of its development path to make decisions about the future of the airport.

It is important to develop performance measures, which will provide meaningful comparison between the study objects. According to Oum et al. (2003, p. 286), there is no accepted industry practice for measuring and comparing airport performance.

The aviation institutions and organizations such as ACI Europe – European region of Airports Council International (ACI Europe 2014), ICAO – International Civil Aviation Organization (ICAO 2013; 2012), and American Federal Aviation Administration (through ACRP – Airport Cooperative Research Programme) have provided their own variations on the key performance areas and indicators. ACRP (2011) has a rather technical approach and focuses on the implementation of a performance management system while ICAO (2013; 2012) has more strategically focus, and the most important of them is ACI Europe – European Region of Airports Council International (ACI Europe 2014), with the widely used key performance areas and indicators within airports worldwide.

ACI is the worldwide professional association of airport operators. ACI Europe represents over 450 airports in 44 European countries. This study objects Mikkeli City airport and Stockholm Skavsta are not members of ACI Europe. In 2012, member airports of ACI Europe handled 90% of commercial air traffic in Europe, over 1.6 billion passengers, 16.7 million tonnes of freight and more than 16 million aircraft movements. ACI Europe (2014) has collected data about KPI`s – Key Performance Indicators, from its 36 active members representing 106 airports since 2003. In the next table (Table 6) is presented the Key Performance Areas (KPA) and Key Performance Indicators (KPI) according to the ACI Europe.

Fig 5.2 Winter airport operations at Hong Kong

5.10 Air traffic management

Air traffic management is an aviation term encompassing all systems that assist aircraft to depart from an aerodrome, transit airspace, and land at a destination aerodrome, including Air Traffic services, airspace management, and Air Traffic Flow and Capacity Management (ATFCM).

The increasing emphasis of modern ATM is on interoperable and harmonized systems that allow an aircraft to operate with the minimum of performance change from one airspace to another (Figure 5.3). ATC systems have traditionally been developed by individual States that concentrated on their own requirements, creating different levels of service and capability around the world. Many Air Navigation Service Providers (ANSPs) do not provide an ATC service that matches the capabilities of modern aircraft, so ICAO has developed the Aviation System Block Upgrade (ASBU) initiative in order to harmonize global planning of technology upgrades.

In the Asia/Pacific Region, the ICAO Regional Office in Bangkok, Thailand is developing a Seamless ATM Plan, which is intended to set expectations for ATM upgrades in the world's busiest aviation region in terms of Revenue Passenger Kilometres. The Seamless ATM Plan is expected to be approved by the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) in mid-2013.

Fig 5.3 Air Traffic Management system

Air traffic control (**ATC**)

Air traffic control (ATC) is a service provided by ground-based air traffic controllers who direct aircraft on the ground and through controlled airspace, and can provide advisory services to aircraft in non-controlled airspace. The primary purpose of ATC worldwide is to prevent collisions, organize and expedite the flow of air traffic, and provide information and other support for pilots.[1] In some countries, ATC plays a security or defensive role, or is operated by the military.

Air traffic controllers monitor the location of aircraft in their assigned airspace by radar and communicate with the pilots by radio. To prevent collisions, ATC enforces traffic separation rules, which ensure each aircraft maintains a minimum amount of empty space around it at all times. In many countries, ATC provides services to all private, military, and commercial aircraft operating within its airspace. Depending on the type of flight and the class of airspace, ATC may issue instructions that pilots are required to obey, or advisories (known as flight information in some countries) that pilots may, at their discretion, disregard. The pilot in command is the final authority for the safe operation of the aircraft and may, in an emergency, deviate from ATC instructions to the extent required to maintain safe operation of their aircraft.

Fig 5.4 Air traffic control

Air Traffic control tower

The primary method of controlling the immediate airport environment is visual observation from the airport control tower. The tower is a tall, windowed structure located on the airport grounds. Air traffic controllers are responsible for the separation and efficient movement of aircraft and vehicles operating on the taxiways and runways of the airport itself, and aircraft in the air near the airport, generally 5 to 10 nautical miles(9 to 18 km) depending on the airport procedures.

Surveillance displays are also available to controllers at larger airports to assist with controlling air traffic. Controllers may use a radar system called secondary surveillance radar for airborne traffic approaching and departing. These displays include a map of the area, the position of various aircraft, and data tags that include aircraft identification, speed, altitude, and other information described in local procedures. In adverse weather conditions the tower controllers may also use surface movement radar (SMR), surface movement guidance and control systems (SMGCS) or advanced SMGCS to control traffic on the manoeuvring area (taxiways and runway).

The areas of responsibility for tower controllers fall into three general operational disciplines: local control or air control, ground control, and flight data / clearance delivery—other categories, such as Apron control or ground movement planner, may exist at extremely busy airports. While each tower may have unique airport-specific procedures, such as multiple teams of controllers ('crews') at major or complex airports with multiple runways, the following provides a general concept of the delegation of responsibilities within the tower environment.

Remote and virtual tower (RVT) is a system based on air traffic controllers being located somewhere other than at the local airport tower and still able to provide air traffic control services. Displays for the air traffic controllers may be live video, synthetic images based on surveillance sensor data, or both.

Ground Control

Ground control (sometimes known as ground movement control) is responsible for the airport "movement" areas, as well as areas not released to the airlines or other users. This generally includes all taxiways, inactive runways, holding areas, and some transitional aprons or intersections where aircraft arrive, having vacated the runway or departure gate. Exact areas and control responsibilities are clearly defined in local documents and agreements at each airport. Any aircraft, vehicle, or person walking or working in these areas is required to have clearance from ground control. This is normally done via VHF/UHF radio, but there may be special cases where other procedures are used. Aircraft or vehicles without radios must respond to ATC instructions via aviation light signals or else be led by vehicles with radios. People working on the airport surface normally have a communications link through which they can communicate with ground control, commonly either by handheld radio or even cell phone. Ground control is vital to the smooth operation of the airport, because this position impacts the sequencing of departure aircraft, affecting the safety and efficiency of the airport's operation.

Some busier airports have surface movement radar (SMR), such as, ASDE-3, AMASS or ASDE-X, designed to display aircraft and vehicles on the ground. These are used by ground control as an additional tool to control ground traffic, particularly at night or in poor visibility. There are a wide range of capabilities on these systems as they are being modernized. Older systems will display a map of the airport and the target. Newer systems include the capability to display higher quality mapping, radar target, data blocks, and safety alerts, and to interface with other systems such as digital flight strips.