

CHAPTER 5

LESSONS LEARNED FROM SUCCESSFUL RAIL SYSTEMS

OVERVIEW

Chapter 4 summarized the results of a review of 14 successful airport ground access systems, each of which was able to capture more than 20 percent of the market of air travelers to public transportation. Chapter 5 examines the attributes achieved in the implementation of the successful system that can be of use to the U.S. practitioner considering the development of systems with both rail and bus services. This chapter examines the characteristics of the rail component of the total ground access strategies used in the 14 successful systems. The focus of the chapter is on the attributes of rail service that are associated with high mode shares to rail systems. The actual method by which these attributes can be achieved in the U.S. experience may be different from the methods used in Europe and Asia.

A REVIEW OF THE RAIL MARKET SHARES

The market share gained by rail service for the 14 successful services is presented in Table 5-1. The criterion for the selection, as reviewed in Chapter 4, was the role of the rail services in a public transportation system that attained more than a 20 percent share of the market. Reference was also made in Chapter 4 to systems for which there is not yet a market survey but whose overall share to public transportation will clearly meet the established criterion: the new rail systems at both the Copenhagen and Stockholm airports. As shown in Table 5-1, the ranking of the 14 rail services cannot be explained by measures as simple as the location or the size of the airport. Almost identical market shares are reported for the airport located closest to the downtown (Geneva) and located furthest from the downtown (Tokyo Narita). Nor can the size of the airport be used to forecast rail market share: the largest airports, Heathrow and Frankfurt International, are in the mid ranks in terms of ground access market share; the smaller airports rank both higher and lower than the largest. This chapter will examine the role of rail services of the 14 successful ground access systems in terms of four major elements of a total strategy, each of which can help to define the key “lessons learned” for the U.S. practitioner considering the implementation of a fixed guideway element of an airport ground access system.

FOUR ELEMENTS IN A SUCCESSFUL AIRPORT RAIL SYSTEM

This chapter will focus on the rail projects that form the principal mode of most of the successful systems described in Chapter 4 by describing the characteristics associated with the success of these rail projects. This chapter will explore the importance of four elements of a total strategy, drawing examples from the systems described in Chapter 4. These four elements are:

1. Service to downtown and the metropolitan area;
2. Service to national destinations beyond the metropolitan area;
3. Quality of the rail connection at the airport, or the airport–railway interface; and
4. Baggage-handling strategies and off-site facilities.

BASIC DEFINITIONS

Metropolitan Services versus National Services

The link from the airport to the downtown is just a part of a larger transportation system to move the user to his or her actual trip destination. This chapter examines the characteristics of service for (1) airport users with local destinations in the metropolitan area and (2) airport users with destinations beyond the metropolitan area. In the European experience, the longer-distance ground access trips tend to be accommodated by national rail systems and are referred to in this report as “national” services. In the U.S. experience, destinations beyond the metropolitan area might be referred to as “statewide” or “exurban” destinations.

For each of the two geographic service categories, two strategies of service are documented: dedicated and shared.

Dedicated versus Shared

Rail services to airports can be categorized as either a *dedicated* service or a *shared* service. With dedicated service, services and vehicles designed specifically for the needs of the airline passenger are provided. With shared service, airline passengers use the same vehicles as other public transportation

TABLE 5-1 Ranking of rail system performance

Rank in sample	City/airport	Rail mode share (percent)	Airport distance (miles)
1	Oslo	43	30
2	Narita	36	42
3	Geneva	35	3
4	Zurich	34	8
5	Munich	31	18
6	Frankfurt	27	6
7	Stansted	27	34
8	Amsterdam	25	9
9	Heathrow	25	15
10	Hong Kong	24	21
11	Gatwick	20	28
12	de Gaulle	20	15
13	Brussels	16	10
14	Orly	14	8

passengers in the corridor of service. In London, both the Gatwick Express and the Heathrow Express rail services are examples of dedicated service, with vehicles designed for the airline passenger. Service to Heathrow Airport on London Transport's Piccadilly Line and other commuter rail services stopping at Gatwick Airport are examples of shared service.

Many dedicated services market their high-quality line-haul times with fast service to only one terminal. Most shared services, such as the Piccadilly Line to Heathrow, provide relatively slow speeds into the city, but with distribution to many points in downtown. In many cases, the dedicated service (e.g., Gatwick Express, Heathrow Express) utilizes a vehicle designed to accommodate checked baggage. In most shared services, such as Munich's S-Bahn service, no specialized vehicle is used, resulting in vehicles that may not serve travelers' need for extra baggage space. Of the 14 ground access systems, 6 can be described as using a dedicated-service strategy. The other systems have chosen to provide service that is designed primarily for the commuters and the rest of the system. A characteristic of the dedicated-service strategy is the ability to provide minimized travel times between the airport

and the downtown. However, the most successful overall mode share is gained by airports that offer a variety of strategies. Table 5-2 presents a categorization of the services offered at each airport.

ELEMENT 1: SERVICE TO DOWNTOWN AND THE METROPOLITAN AREA

In the case studies of successful rail services to downtown, two strategies for service design emerge: (1) focusing on the line speed to the terminal or on the quality of distribution services, and (2) minimizing the headway that comes from joint operation with regularly scheduled services. Both strategies seek to produce a door-to-door travel time that is competitive with the taxi and the private vehicle. In the comparison of the two strategies, the Oslo Airport Express can be used as a prototype of the high-speed, dedicated strategy; Munich's standard S-Bahn can be a prototype of the lower-speed, shared strategy. In the last year, service was improved in Oslo by decreasing the line time, while service in Munich was improved by doubling the number of trains, thus lowering the waiting time by 50 percent.

Dedicated Express Service to Downtown

Until recently, trains dedicated to the needs of airport users operated only to London Gatwick and Tokyo Narita Airports. In 1998 and 1999, there has been a significant expansion of the application of the dedicated train, with exclusive service to the downtown terminals. In these 2 years, new dedicated services opened in Hong Kong, Oslo, London (at Heathrow Airport), Milan, and Stockholm. In addition, new rolling stock, with new branding, is being introduced at London's Gatwick and Stansted Airports. During this period, plans for such dedicated express services were announced for Paris, Berlin, and Kuala Lumpur.

TABLE 5-2 Categorization of line-haul services

Airport	Rail mode share	Dedicated train		Shared train	
		CBD	National	CBD	National
Oslo	43	Yes	Yes	Yes	Yes
Tokyo Narita	36	Yes	Yes	Yes	No
Geneva	35	No	No	Yes	Yes
Zurich	34	No	No	Yes	Yes
Munich	31	No	No	Yes	No
Frankfurt	27	No	No	Yes	Yes
Amsterdam	27	No	No	Yes	Yes
London Heathrow	25	Yes	No	Yes	No
London Stansted	25	Yes	No	Yes	Yes
Hong Kong	24	Yes	No	Yes	No
London Gatwick	20	Yes	No	Yes	Yes
Paris de Gaulle	20	No	No	Yes	Yes
Brussels	16	No	No	Yes	Yes
Paris Orly	14	No	No	Yes	No

The Role of High-Speed, Dedicated Service: Oslo, Hong Kong, London Heathrow, and Milan Malpensa

Oslo Airport Express. The Oslo Airport Express train, which has the highest mode share to rail in the sample, can be used as an example of a strategy that is based on a determination to attain high running speeds and low terminal-to-terminal travel times. The train is shown in Figure 5-1.

The fast running speeds and short travel times were established as part of a larger political process of siting a new airport for Oslo. After several years of design activity at a different site, the Norwegian government selected an existing military airport at Gardermoen, located 30 mi north of Oslo. A political goal was established: the running time of the train to the new airport be no longer than the running time of the bus from the existing airport—19 min. Planners established the need for high speed by examining comparative total trip times (see Figure 5-2). A major financial commitment was then made to bring about these short travel times, with about Nkr 7 billion (US \$900 million) spent on the airport–rail connection. Of this, about Nkr 5.6 billion (US \$722 million) was for the infrastructure and Nkr 1.4 billion (US \$180 million) for the rolling stock.

For this investment, the government set the following policy goal: the airport rail system would attract 50 percent of the market, a mode share considerably higher than any system had attained to date. Of this desired share, 42 percent was set as the goal for the Oslo Airport Express service, with an 8 percent goal established for the traditional national train service. With about 12 million nontransferring air passengers, some 6 million air passenger rail riders were forecast. In addition, a policy goal has been set to attract 40 percent of airport-based employees to the combined rail system. The original operating plans called for the operation of 200 Airport Express trains and 94 state railway trains using the new airport station each day. The high-speed strategy focused on the need to bypass a slow section of local track just east of Oslo and to construct a new 14-km (9-mi) tunnel. Construction problems with the tunnel, which are now resolved, delayed opening of this segment until 1999.



Figure 5-1. The Oslo Express train, an example of dedicated express service.

SOURCE: Adtranz.

In Oslo, the strategy to provide high-speed service to the downtown and additional direct service beyond has resulted in a 39 percent market share for the dedicated Airport Express train and another 13 percent mode share to the slower, lower-priced Norwegian Railway. The new tunnel segment has now opened, making possible the originally planned 19-min travel time to the downtown terminal, compared with the 33-min travel time during the temporary service. In addition, trains now operate every 10 min, compared with the earlier 15-min headway. Data will soon be available on any change in market share resulting from these two changes in trip characteristics.

The need for line-haul speed is reflected in the design of the new trainsets for the Oslo Airport Express. Because the dedicated trains are also used in service beyond the downtown, the trains were designed to meet the standards of the national intercity network. New high-speed trains, designed for 250-kph (155-mph) service, are now running at 210 kph (130 mph). Each train has 175 seats; two trains are coupled together for peak-hour service. The trains represent the state of the art, providing a “business-class” seating standard throughout; no separate first-class seating is offered. The strategy for baggage handling is discussed later in this chapter. One of the trainsets has been equipped with the tilting technology used on Sweden’s highest-speed intercity trains (41).



Figure 5-2. Door-to-door travel times were used planning the Oslo Airport Express.

SOURCE: Oslo Airport at Gardermoen.

Hong Kong Airport Express. The Hong Kong Airport Express Line (Figure 5-3) is one element of a larger plan to provide two categories of service on one rail infrastructure. A new commuter train for general-purpose use has been developed for Lantau Island, the location of the new Hong Kong Airport. The interior of the commuter train looks very similar to the high-volume service offered by MTRC throughout Hong Kong. All seating on the commuter train is on long, unupholstered bench seats, which are used by rapid transit systems around the world to maximize room for standees. Ticket pricing is consistent with the costs of other mass transit services in the area.

Superimposed on this infrastructure is an elaborate “skip stop” operation, in which the express trains are routed onto short bypass tracks at each of the local stations. Although the bypass tracks are in operation at the local stations, the fundamental infrastructure—particularly in expensive tunnel and bridge segments—is that of a two-track railroad. In effect, two complete systems must be dispatched simultaneously, resulting in a precisely managed rail operation. Little tolerance exists in either system for failure or delay in the other system.

The result of this skip stop operation is an imaginative marketing concept, in which two classes of service—aimed at two very different submarkets—are operated over a common infrastructure. The users of the local train never see the elaborate check-in stations in Central Station or Kowloon Station, because those users are routed into standard stations. The users of the Airport Express are, generally speaking, not aware that the same rail company is operating a second service to the airport complex at a fare one-third to one-quarter of what the Airport Express users are paying.

The creation of a high-speed service with a higher ticket price is the result of a marketing plan to provide a service with a high level of amenity for the airport user, while sharing infrastructure investment with the commuter system run by MTRC. The rail line to Lantau Island cost more than HK \$34 billion (US \$4.5 billion). The express service offers a 23-min travel time from the airport to the downtown.



Figure 5-3. The Hong Kong Airport Express.

SOURCE: Mass Transit Railway Corporation, Hong Kong.

Heathrow Express. The Heathrow Express, shown in Figure 5-4, was designed to provide a high-speed alternative to the existing rail transit service to Heathrow Airport. A political review in 1983 of the future of Heathrow determined the further growth of the airport should be contingent on the creation of a high-speed rail link. From Paddington Station, the existing intercity tracks are shared with other rail operators for 19 km (12 mi), at which point a new flyover leads to a new right-of-way, which tunnels into Heathrow’s central terminal area. At this location, the front of the platform leads to escalators for Terminals 2 and 3, while the back of the platform connects to Terminal 1. A single-track tunnel continues on to Terminal 4, which has two platforms.

The express train project was built for £422 million (approximately US \$675 million). Nonstop service is provided between Paddington Station and Heathrow’s central terminal area, at an advertised time of 15 min.

Milan Malpensa Express. Service to Milan’s Malpensa Airport is being phased in incrementally. When the airport opened in 1998, few ground access services were available by any mode. In 1999, the initial phase of the Malpensa Express was inaugurated with constrained service levels caused by a long, one-track segment. Service to downtown Milan, now offered every 30 min, will improve when the full double-tracked right-of-way is constructed. The major airline, Alitalia, operates one of the train cars and offers “flight” attendant service to those with Alitalia tickets (42).

Planned Services with the Dedicated-Express Concept: Berlin Brandenburg, Kuala Lumpur, and Charles de Gaulle

Berlin Brandenburg. In 1999, German Railways announced its decision to develop a dedicated train to operate



Figure 5-4. The Heathrow Express at Paddington Station.

Photo: Matthew A. Coogan

express service to the new Berlin Brandenburg International Airport, which will consolidate and replace the existing airports in Berlin. An S-Bahn suburban rail line already serves the site for the new airport, currently called Schönefeld Airport, with a 25-min service to downtown.

The S-Bahn division of German Railways will develop a new dedicated express line that will connect with Berlin's new central rail station—called Berlin-Lehrter Bahnhof—with only two intermediate stations. The specially designed trains will be capable of 100-mph service and will reduce the running time to downtown to 18 min. Some dedicated trains will continue beyond the CBD to serve the suburb of Potsdam, to the west. Adtranz will build the trains, which will have all seats facing a baggage-storage area, as originally developed for the Oslo Airport Express train. As shown in Figure 5-5, the new German service will be branded as the “Airport Express.”

Kuala Lumpur. In Malaysia, Kuala Lumpur trains will run every 15 min, making the 57-km (35-mi) service to downtown less than 30 min. Slower, cheaper commuter trains will also be operated along the line to downtown Kuala Lumpur. Called the Express Rail Link (ERL), it is a high-quality, high-amenity service, designed to appeal to air travelers. The proposed baggage strategy for the Kuala Lumpur system is the most ambitious in the world and will be discussed later in this chapter.

Charles de Gaulle. For years, the access strategy between Charles de Gaulle Airport and downtown Paris has been based on the use of standard regional rail services, which are shared with commuters. No use of specialized service to the downtown was planned.

Now, French National Railways (SNCF) and Aeroports de Paris are developing a new dedicated, high-speed service to a downtown terminal—either Gare du Nord, terminal of the Eurostar train from London, or the immediately adjacent Gare d'Est. Thus, Charles de Gaulle Airport will soon have two services available to the customer, at two separate price points. Reportedly, the new trains will be similar in market-



Figure 5-5. Concept design for the Berlin Airport Express train.

SOURCE: Adtranz.

ing concept to the existing TGV, although the actual distances may not require true high speeds.

Specialized Airport Access Design: Information to the Passenger

Many of the new dedicated trains incorporate innovative information systems to help the passenger on the airport trip. An early example of such information is the use of map graphics on the Narita Express, which show the traveler the location of the train on the map, the actual time, and the expected arrival time at the airport. At all times, the rail rider has a sense of orientation and is (presumably) reassured that the airport time connections can be met. In the Hong Kong Airport Express, an arcing space at the ceiling over the center aisle is used to show an electronic map that has the downtown on the left and the airport on the right. As the train proceeds through the journey, its location is shown on the electronic map.

The Hong Kong railcar is unique in its use of seat-back televisions for every rider, as shown in Figure 5-6. These television screens offer several channels of content, ranging from stock-market summaries, to airport information, to comic silent movies. At present, airline schedule information is provided; there are no plans to add real-time information about airline flights. The televisions are heavily used, and, according to an unscientific survey, most riders select the silent movies.

The Heathrow Express and Oslo Express vehicles both place standard television screens near the doors (Figure 5-7). The layout of the Oslo train allows the television to be placed in the storage bin located in the center of the aisle, a highly visible location for the television. Immediately before departure and arrival, the television displays information about the departure and arrival times. During the journey, the Heathrow Express presents the BBC world news. The content of the television program is sequenced by trackside radio beacons: for example, the message “We are about to arrive at Heathrow” is triggered when the train passes the appropriate point.

The Hong Kong system is based on silent images throughout; the Heathrow Express pipes the soundtrack of the television content throughout the vehicle. Users of cell phones compete with the sound of the television service. To deal



Photo: Matthew A. Coogan

Figure 5-6. Hong Kong Airport Express televisions are located on each seat back.



Photo: Matthew A. Coogan

Figure 5-7. Heathrow Express televisions are located near the doors.

with the conflict, a “silent zone” is offered in both first-class and standard compartments, in which occupants are asked to refrain from using cell phones. (U.S. application of television systems for essential information may need to incorporate sound to comply with the Americans with Disabilities Act [ADA] regulations.)

Shared Local Service to Downtown

The Role of Low-Speed Shared Service: Munich

Although several cities have chosen to create dedicated, express airport services, most of the airports in the sample are served by rail lines, which are also used by daily commuters. Munich can be used as an example of a local strategy, because, as shown in Figure 5-8, the airport station is served only by conventional metropolitan railway equipment, with no direct national service. Recently, the Munich S-Bahn system made a major improvement to airport service with the addition of a second local rail line, making no change in the basic strategy to serve the airport with the existing metropolitan rail system.

In 1998, the Munich system doubled the amount of service to the airport, with standard local equipment providing service that is shared with the other users of the system. A new line has been extended for 7 km (4 mi) from an existing route, the S-1 (shown at the left end of the dotted line on Figure 5-9), at a cost of DM 220 million (US \$121 million). In the first months of the new service, ridership from the airport station increased by 7 percent, with air passenger mode share rising from 28 to 31 percent. This increase in ridership is notable, in that the actual travel time by either of the two lines to downtown remains about 40 min, which is similar to that of the London Underground from Heathrow Airport but worse than that of most other local airport services.

The managers of the Munich S-Bahn system developed a highly innovative method of providing the extra service to the



Figure 5-8. The two Munich airport lines operate with standard S-Bahn trainsets.

SOURCE: Munich S-Bahn.

airport. Because there was no room in the schedule of the S-1 line for additional trains, the decision was made to serve two destinations with one line by splitting each train into two trains at Neufarm Station, as shown in Figure 5-9. The front cars of the train continue on to the airport, and the back cars of the train continue on the existing service to its terminal at Freising. In the opposite direction, the procedure takes about 4 min.

With the combined services of the two lines, the airport gets a combined 10-min headway, with no change of vehicle service to 9 downtown stations and immediate connections to 10 local rail lines and the national rail system at the central station.

The choice of shared service has led to problems. Initially, the airport opened with a check-in center located at the central railroad station. However, there was no way for the standard commuter equipment to accommodate the baggage because space onboard was needed for use by passengers. The baggage was placed on the airport bus, which operates to the central rail station. However, the downtown baggage check-in service was abandoned for lack of use.

Characteristics of Low-Speed Shared Service: Interconnections with the Local System

The provision of airport services shared with the local rail system has the potential of providing multiple points of transfer with other elements of the metropolitan system. Although the multiple stops associated with most local rail services provides for slower line-haul speeds, these stops allow for more points of interconnection than are provided by an express service to one or two terminal locations.

Between Munich Airport and Hauptbahnhof Station (the central station), there are 13 intermediate stations, making connections with 14 separate connecting rail lines (see Figure 5-8). Planners estimate that 80 percent of S-Bahn users take a second train to get to their destination.

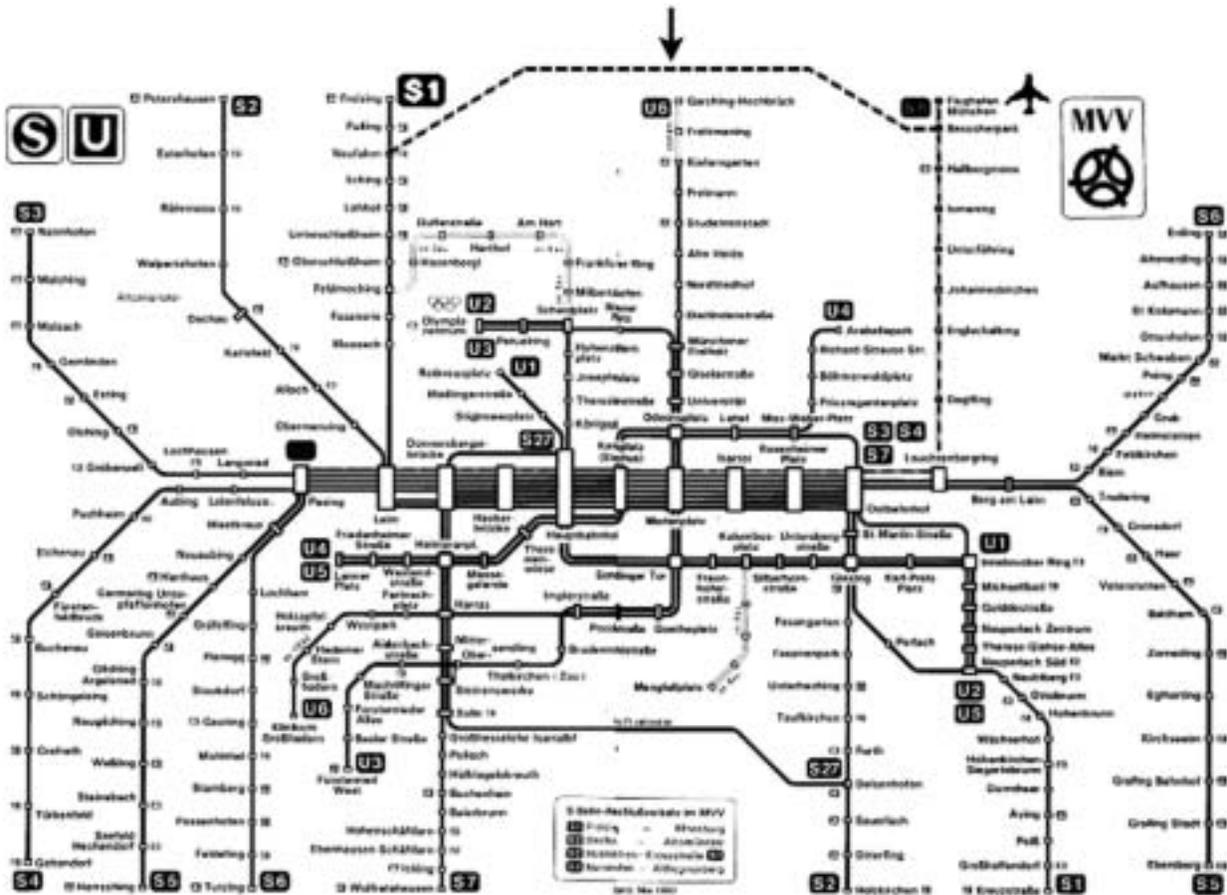


Figure 5-9. The dotted line shows the extension of a branch of the S-1 line (left) to the S-8 line (right) at the Munich airport.

SOURCE: Diagram adapted from MVV brochure.

Between Heathrow Airport and Kings Cross Station, the London Underground's Piccadilly Line has 23 stations and connections to 12 separate routes. Thus, service is available to virtually all of central London with only one rail transfer, as shown in Figure 5-10. The Piccadilly Line of London Transport uses standard rapid transit rolling stock, with low-speed operation, and captures about 14 percent of the market from Heathrow Airport. See Figure 5-11.

Germany and France have developed a hybrid metropolitan transit train that incorporates the higher speeds of commuter rail with the downtown distribution characteristics of rapid transit systems. Both the Frankfurt S-Bahn and the Paris RER (electrified suburban rail network) (Figure 5-12) systems are designed to maximize the quality of transfer through the rest of the system. The Frankfurt system captures about 21 percent of the market; the Paris RER captures 16 percent of the Charles de Gaulle Airport market.

The primary market for all these shared local services, however, is not the airport user, and the systems tend to operate at capacity during rush hours. Finding room for baggage becomes an annoyance to the air traveler and to the com-

muter alike. The physical design of many commuter transfer stations does not accommodate the needs of travelers who have baggage.

Lessons Learned: Successful Systems to Downtown

Express Service versus Multistop Service: The Role of Distribution

In each of these examples, the line-haul travel speeds from the airport to the center city are slow, but the service is well integrated with local distribution systems. In each of these airports, the local rail service, with its shared services, captures more of the market than does any other service.

An example can be observed in London: service on the Heathrow Express takes about 17 min to Paddington Station, leaving every 15 min. Piccadilly Line service to downtown takes about 40 min, leaving every 4 min. The express train user waits an average of 7.5 min and travels 17 min, for a total travel time to Paddington Station of about 25 min. The walk



Figure 5-10. The Piccadilly Line from Heathrow Airport offers direct connections to most of London's rapid transit system.
SOURCE: London Transport.



Photo: Matthew A. Coogan

Figure 5-11. The London Underground is poorly configured for passengers with baggage.



Photo: Matthew A. Coogan

Figure 5-12. The rail station at Charles de Gaulle Airport is served by the RER System.

from the express rail platform, through the Paddington station complex, to the specific underground platform takes about 7 min. The headway of the connecting service may add another 5 min of waiting time. Examination of total trip times shows that there are only a small number of Underground stations (the immediately adjacent stations on lines connecting from Paddington) at which the total travel times for the Heathrow Express plus Underground are superior to the Underground plus Underground travel times. (This analysis is based on unweighted transfer times; it is customary in the analysis of transit times to weight the time spent waiting for a vehicle as at least two times that of the time spent on the moving vehicle. With such an assumption, the 4-min headway of the slower train results in a perceived travel time to downtown that is competitive with that of the faster train with the 15-min headway.

Two markets are revealed: when the journey is to be completed by taxi, the benefits of the express train to one terminal are obvious; when the journey is to be completed by local transit, much of the travel time superiority is lost when the user has to make the transfer onto the local transit system.

Even with significant differences in line-haul times, for many air passengers the modal decision may be less driven by in-vehicle travel times than by the convenience of the trip.

Shared services make the air traveler endure whatever level of overcrowding exists on the rail vehicle during rush hour, which, in London, can be a serious problem. Dedicated services provide guaranteed quality of service on the line-haul segment, leaving the user with the need to find adequate distribution from the rail terminal.

The Emergence of New Services: Fast Line Haul, Good Distribution

Officials at BAA, which owns the Heathrow Express, are now developing service concepts that address the problem of integration into the rest of the transportation system. Within the next 3 years, another Heathrow Express service will be added to St. Pancras Station, with stops at intermediate stations to the north and west of London, as shown in Figure 5-13. In this service concept, Heathrow Express service to both Paddington Station and St. Pancras Station would be offered every 15 min. A rider simply seeking the first line haul into the downtown system would have service available every 7.5 min.

As an interim step to this improvement in distribution quality for the Heathrow Express, a new express service to Paddington Station that stops at intermediate rail stations will soon be inaugurated. Stops at these transfer stations will allow

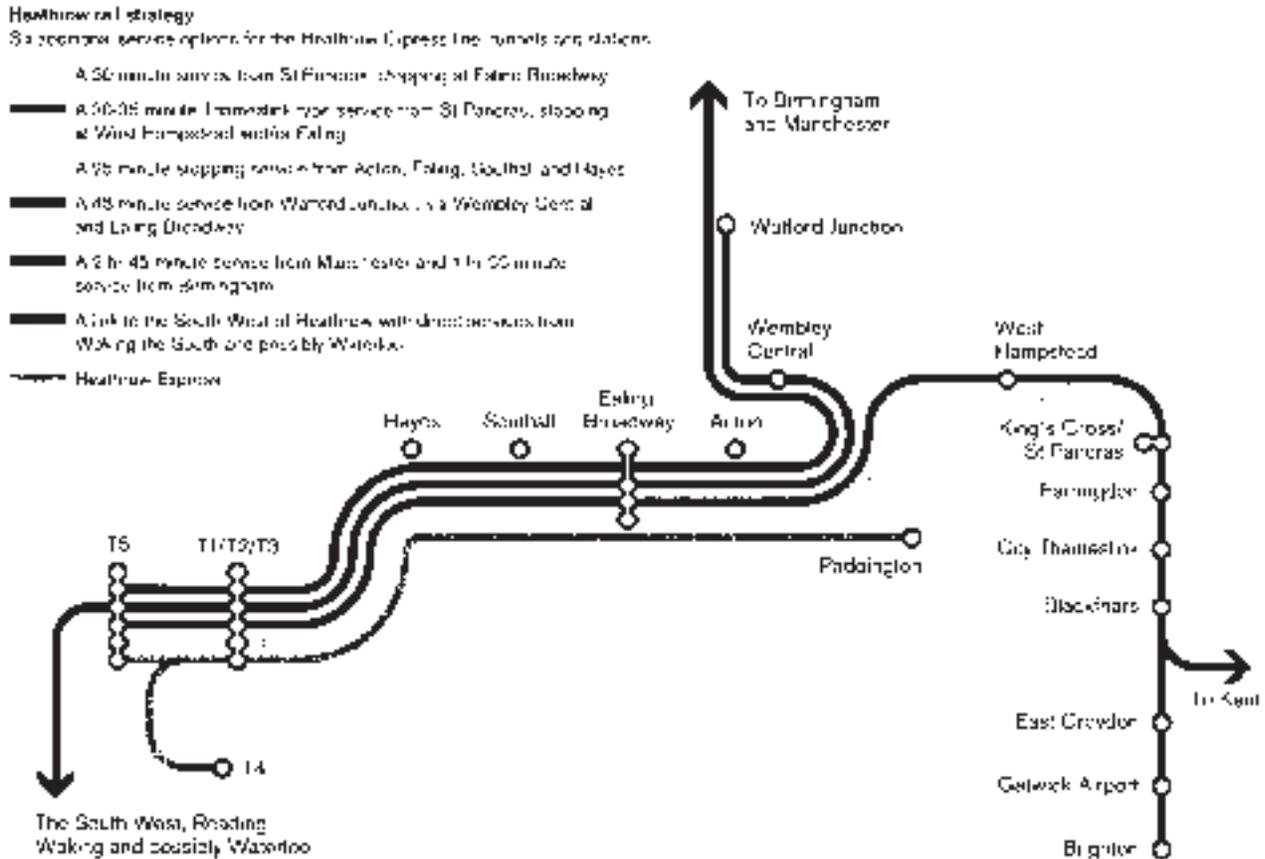


Figure 5-13. In the future, the Heathrow Express will be integrated into the suburban rail network. SOURCE: BAA (formerly British Airports Authority), Heathrow Airport Transportation Policy—Factfile, internal document, 1997.

rail passengers arriving from the west to intercept the Heathrow Express trains earlier and to reduce their travel times. One of these stations—Ealing Broadway Station (see Figure 5-13)—will provide transfer to the London Underground rapid transit lines, creating more options for distribution throughout the network.

A Case Study: Fast Service versus Slower, More Direct Service

Planners at the Hong Kong MTRC have been examining the competitive market position of the fast rail and the slower bus services available to the air passenger. High-quality, air-conditioned buses, which are often double-decked (see Figure 5-14), provide direct service to many urban destinations.

Looking only at travel from the airport to downtown (Central Station), the fast train provides service in 23 min, at HK \$70 (US \$9.05). The Airbus A route takes 48 min and charges HK \$40 (US \$5.15), while the standard city bus takes 53 min and charges HK \$21 (US \$2.70). The rail gained 21 percent of the market, the airbus took 16 percent, and the city bus took 20 percent.

The factors that result in this high mode share to bus seem to include more than price minimization, because MTRC provides good lower-priced service to the airport complex. From the beginning, planners designed the rail system to operate with two price points. While the Airport Express Line train to downtown operates directly from the passenger terminal for HK \$70 (US \$9.05), a second train, reachable by shuttle bus, operates from a nearby station. The entire trip (shuttle plus train) on the standard train costs only HK \$23 (US \$3), which is directly comparable with the cost of the city buses. In fact, the user of this connection can get to Central Station in only 39 min, compared with 53 min on the city bus. But for this price-sensitive market, the shuttle bus-to-rail connection is capturing only 3 percent of air passengers; the direct city bus



Figure 5-14. Hong Kong International Airport is served by buses offering direct services to many local destinations.

captures 20 percent. The bus system serves many area destinations directly, with no change of mode required for the trip. For the air traveler, directness of service may be more important than price minimization or line-haul speed to the terminal point (43).

In order to understand the motivation for mode choice—and to explore the attribute of directness of service—MTRC managers undertook some market research. Of those riders on the direct bus routes, an expected 55 percent said that the lower fare was a reason for choosing the bus; importantly, 51 percent stated that directness of service (i.e., no need to transfer) was a reason for their choice of mode. Directness of service was considered a factor by only 18 percent of rail riders, presumably those with destinations convenient to the terminals.

Of those riders on the Airport Express, an expected 63 percent stated that speed was the reason for choosing the rail. Some 13 percent of the rail users mentioned the fare as the reason, which is lower than the fare for either taxi or airport door-to-door bus service.

In an important conclusion, one of the original architects of the Hong Kong Airport Express writes:

“It is apparent that even with a good design and well-integrated railway service, the Airport Express does not have inherent advantages over more direct single mode bus travel. In other words, the speed advantage of rail versus single mode road competitors when traveling over distances of only up to 34 km [21 mi] do not result in significant enough time savings to compensate for the necessary transfer.” (44)

Lessons Learned: The Importance of Line-Haul Speed

Comparative Line-Haul Travel Times

The examination of relative line-haul speeds in the database of successful international airport rail operations has several key implications for the U.S. practitioner.

The first implication, and by far the most important, is the difference that exists in the basic travel-time conditions, largely associated with the existence of fast highway connections in the United States. Four of the airports in the sample offer service to downtown that is twice as fast as automobile service. Table 5-3 shows that automobile travel times in Oslo are two-and-a-half times as long as the rail line-haul time. Table 5-3 shows many examples in which the automobile travel times are significantly higher than the rail travel times. Given the extent of roadway investment in the United States, attaining similar relative travel-time advantages for rail services will be difficult in most U.S. applications.

The second implication is that the rankings of services by relative travel times to downtown do not correlate linearly with the rankings by mode share performance. The data reveal that

TABLE 5-3 Comparisons of line-haul time, by modes and distance

Rank in sample	City/airport	Rail mode share: percent	Car time to CBD: minutes	Rail time to CBD: minutes	Ratio	Airport distance: miles
1	Oslo	43	50	19	2.6	30
2	Narita	36	90	55	1.6	42
3	Geneva	35	10	10	1.0	3
4	Zurich	34	20	10	2.0	8
5	Munich	31	35	40	1.1	18
6	Frankfurt	27	20	12	1.7	6
7	Stansted	27	70	40	1.7	34
8	Amsterdam	25	30	17	1.8	9
9	Heathrow	25				15
	Heathrow Express	11	45	15	3.0	15
	Piccadilly Line	14	45	45	1.0	15
10	Hong Kong	24	35	23	1.5	21
11	Gatwick	20	80	30	2.7	28
12	de Gaulle	20	45	35	1.3	15
13	Brussels	16	20	14	1.4	10
14	Orly	14	25	35	0.7	8

it is the comparative travel time on a door-to-door basis that seems to influence choice. The data presented in Table 5-3 show that the focus on travel time to one point may be unproductive. There are many points in central London where the slower mode (i.e., the Underground) gets the traveler to the destination without the negative experience of the transfer. There are many points in Hong Kong where the slower mode (i.e., the direct bus) serves the traveler more directly than the faster mode.

The third implication is that the travel-time characteristics to downtown may not be a good surrogate for the travel-time characteristics to the actual destinations of the users. The travel time to downtown Geneva is an interesting piece of information, but 75 percent of those leaving the Geneva Airport are not going to the city of Geneva. The ratios of comparative travel times to Lausanne or to Bern are considerably more favorable to rail. The service must be designed based on the understanding of the needs of the users and must reflect the actual spatial distribution of trip-end destinations.

ELEMENT 2: SERVICE TO NATIONAL DESTINATIONS BEYOND THE METROPOLITAN AREA

In 1980 in Zurich, the Swiss National Railways implemented the first airport–rail connection designed to link to a full national network rather than to just the immediate downtown and surrounding area. Before this time, other early rail lines, such as that serving Brussels Airport, were basically stub-ended terminals of local suburban railways. Even the most advanced connection—British Rail to Gatwick Airport—was marketed primarily to downtown London. But the Swiss system was marketed as a direct path to all major national destinations.

Twenty years later, airports throughout Europe are connected to national systems. Overwhelmingly, these national

connections are not provided by specialized dedicated services but feature integration with traditional national rail services. However, a few examples of dedicated services for areas beyond the downtown have been operated and are summarized below. These services include the early efforts by Lufthansa to provide national rail service exclusively for air passengers.

Dedicated National Service

Lufthansa Airport Express

The earliest example of the use of specially built equipment for national intercity connections was the Lufthansa Airport Express (Figure 5-15), which started service between Frankfurt and Düsseldorf International Airports in March 1982. In 1990, service was inaugurated to Stuttgart. Significantly, the dedicated service was replaced with a shared-rail



Figure 5-15. The Lufthansa Airport Express was an early example of a dedicated service to national destinations.

SOURCE: German Railways.

service, which accommodated air passengers on regularly scheduled national trains.

Between 1982 and 1990, ridership on the line to Cologne grew from 62,000 passengers to 216,000. However, an examination of the markets for which there was also air service (to either Cologne/Bonn or Düsseldorf Airports) reveals that more than 600,000 passengers per year chose the plane and 200,000 passengers per year chose the train. It is estimated that the dedicated train captured 28 percent of the airline market to Bonn, 37 percent of the market to Cologne, and 35 percent of the market to Düsseldorf (45).

On the line from Cologne, baggage check-in occurred on the train, with agents accepting bags at the traveler's seat. On the line from Stuttgart, check-in occurred at the train station. Airline through-tickets were available for train stations in Düsseldorf, Cologne, Bonn, and Stuttgart.

By the mid-1990s, the Lufthansa Airport Express was operating in competition with many national rail services. Lufthansa Express operated only 4 trains per day toward Cologne; the national system operated 21 trains per day in the same corridor. The net result was that a ticket holder on the dedicated Lufthansa Express might wait on the platform, watching numerous fast trains go to his or her exact destination.

With the introduction of 185-mph ICE trains on four routes out of Frankfurt Airport, it became clear that utilizing the national rail network made more sense than continuing operation of specialized trains just for airport passengers. Lufthansa abandoned the separate train service and began a program to reserve certain seats on the standard national rail train.

Narita Express

JR East Railway's Narita Express operates dedicated airport rail service to six additional destinations beyond the CBD. However, most passengers use only the segment from Tokyo's Central Station to the Narita airport (see Figure 5-16). In general, connections between Tokyo Narita Airport and the national rail destinations are made by transferring at Central Station.



Figure 5-16. The Narita Express offers dedicated airport rail services to six stations beyond the CBD.

SOURCE: JR East website (www.jreast.co.jp/nex/index.htm).

Oslo Airport Express

Although most dedicated services do not go beyond the primary metropolitan area, the Oslo Airport Express is designed to provide specialized airport-oriented rail equipment on longer-distance connections. Of the six trains per hour that serve Oslo's Central Station, three continue toward the south and west.

Summary

In general, rail services from airports to destinations beyond the primary downtown area are provided by the national inter-city rail network and are not dedicated to the air passenger. The case of the Lufthansa Airport Express demonstrates the difficulty of providing such services to a limited market over long distances. However, the success of the Oslo Airport Express, which is offered to several cities, is an example of the use of dedicated equipment to serve markets beyond the CBD.

Shared National Service

Integration with the National Rail System: Copenhagen

In Switzerland, the Netherlands, and Denmark, there are good examples of the integration of airports into national rail networks. A good example of national integration was the opening in 1998 of national rail services to a new station at Copenhagen Airport. The rail station at the airport is expected to attract about 4 million passengers in 2000 and 5 million by 2005. It is forecast that 1.4 million passengers from Sweden will use the new cross-sound rail service to the Copenhagen airport (46).

Swedish air passengers will access Copenhagen Airport over a new 18-mi bridge-and-tunnel connection between Denmark and Sweden (depicted in Figure 5-17). The combined highway-and-rail connection will cost about Skr 34 billion (US \$4 billion). The new rail trains for the binational service will cost Skr 2.3 billion (US \$270 million). Service across the channel to Sweden will operate every 20 min.

A proposed timetable from Copenhagen Airport shows six trains per hour departing for Danish destinations and four trains per hour departing for Swedish destinations. Seven trains a day would proceed to Stockholm, and five trains a day would connect the Danish airport with Gothenburg. It is calculated that a train will either arrive or leave every 4 min in rush-hour service. The combined departures will make the airport rail station one of the busiest in the world.

The air passenger boarding a train at Copenhagen Airport will be able to purchase an integrated public transportation ticket, covering all public modes needed to reach his or her destination. A single tariff system has been designed, which has 7 fare zones on the Danish side and 10 fare zones on the



Figure 5-17. Copenhagen Airport is served by a new national and international rail system.

SOURCE: *We Are Linking the Øresund Region Together: A Fixed Link to the Future: Trains and Buses in an Integrated Public Transport Network with a Single Tariff and Ticket System*. Danish State Railways, Statens Järnvägar, and Hovedstadens Trafikselkab, Copenhagen, 1977.

Swedish side of the sound, that serves all combinations of bus and rail travel within the newly united region. Through fares will be designed so that the integrated ticket will always be cheaper than the sum of the separate tickets. The associated companies are spending Skr 0.5 billion (US \$61 million) to bring about the integrated fare collection system (47).

Rejection of Dedicated Service for Air Passengers

Although dedicated express airport services are being developed in many areas around the world, managers of the Danish and Swedish rail systems are taking the opposite approach. No attempt is being made to offer separate services to air passengers. Rather, the Danish rail system serving the airport is being restructured to offer passengers the kind of amenities associated with a dedicated express concept. Most European railways offer two classes of service; Danish Railway has offered a third—"super first class." Called "Business Plus," the service includes a meal and often a compartment containing business equipment. In a highly unusual marketing scheme, Danish Railway charges a fixed price without regard to the distance of the trip.

Danish rail officials are now implementing a program of joint ticketing in which the price of the rail journey is included in the airline ticket. A pricing system based on four zones is being used for the unified air-rail ticket. This new kind of

ticket will supplement the existing national program of integrated rail and bus tickets. The ground access system serving Copenhagen Airport provides a good case study for the integration of air and rail services, because at all times it serves the air passenger with services primarily designed for the national intercity market.

National Systems: Standard Speed Intercity Rail

Switzerland. The connection of the Zurich airport to the Swiss National Railway system in 1980 has resulted in significant passenger growth for the airport rail service. Between 1981 and 1989, rail traffic from the airport grew by 74 percent, while air traffic as a whole (including connecting airline passengers) increased by 67 percent (48). In 1987, Geneva Airport opened its rail station to complete the system.

It is estimated that 33 percent of Zurich Airport air passengers using the rail system come from the city of Zurich and another 8 percent come from the rest of the metropolitan area. Thus, some 59 percent are coming from outside the metropolitan area. For Geneva, only about 25 percent of the air passengers using the rail come from the city of Geneva, and 75 percent come from the rest of Switzerland and from France (49).

Currently, the Zurich airport is served by more than 170 trains per day, and the Geneva airport is served by 130 trains per day. Service is provided every hour on the main east-west line linking Zurich and Geneva.

Amsterdam. Like both Zurich and Geneva, the rail station at Amsterdam's Schiphol Airport is located on the national east-west trunk line and has direct service to most of the Netherlands. The airport is served by 550 trains per day.

Oslo. In addition to the operation of dedicated service to three corridors, Oslo Airport is served by traditional Norwegian State Railways services, as part of a national program to upgrade the railways' intercity network to the standard of 125-mph service. Figure 5-18 shows the travel-time difference that the national upgrading program will provide to the users of the new airport—as much as 50 min of travel-time savings.

National Systems: High-Speed Rail

France and Germany have established airport access concepts that are fundamentally different from those adopted in most other airport access systems; both countries are building new, dedicated rights-of-way for high-speed rail into their largest national airports. Amsterdam's Schiphol Airport is served by the Thalys trains, which currently achieve 180-mph service only between Brussels and Paris.

Germany. Germany is now building rail infrastructure, which will take the new ICE train directly to airports in

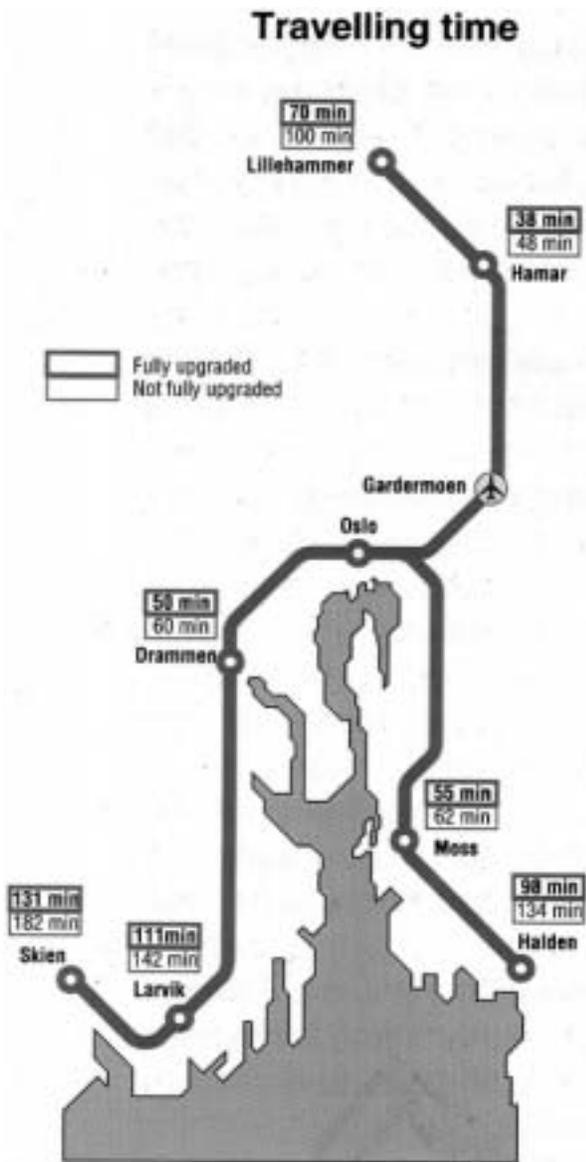


Figure 5-18. Norway is improving its intercity rail travel times to serve the new airport.

SOURCE: Norwegian Railways.

Frankfurt, Cologne/Bonn, and Leipzig/Halle and to a new AirRail station connected to the Düsseldorf Airport via a people mover. The first of these stations designed specifically for high-speed rail services opened in 1999 at the Frankfurt airport. The Frankfurt investment is the cornerstone of a national policy to expand Frankfurt Airport (and implicitly the role of the national airline) for international traffic.

Frankfurt Airport is developing an ambitious program to replace short-distance airline feeder services with improved rail connections. Only a limited number of slots are available for use at the Frankfurt airport; airport officials believe that the overall productivity of the airport can be increased by reallocating these slots for longer-distance flights.

The long-term plans for the expansion of Frankfurt Airport call for an increasingly important role for high-speed rail. In 1991, fewer than 10 percent of air travelers used the various national services, with about 19 percent using the local S-Bahn metropolitan railway. By 2010, airport forecasts call for 28 percent of air travelers to access the airport by the national railway and 15 percent by local railway. Thus, the goals of the airport call for nearly a three-fold increase of the present role for intercity rail to destinations beyond the metropolitan area.

France. SNCF is investing heavily in a new rail system to serve Charles de Gaulle Airport. A new circumferential rail line has been built bypassing Paris, allowing trains from the north (from Lille, London, or Brussels) direct service to the south (such as to Lyons and Nice). The new TGV service promises a travel time from Charles de Gaulle Airport to Brussels of 1.5 hr and to Lyons of 2 hr. Ultimately, full implementation of the high-speed rail service in England would allow for a 3-hr travel time to London. At the present, the market for these services is building slowly, with about 3 percent of airport passengers using the TGV services.

Extension of the French–British “Eurostar” Channel train to Heathrow Airport is under preliminary discussion.

Lessons Learned: Integration with the National System

In the examples above, whether the integration is with high-speed technology (France and Germany) or intercity rail service (Denmark, Switzerland, and the Netherlands), the airport strategy takes advantage of a capital investment decision already made for the rest of the national network. It is important to emphasize the scale of the national rail networks into which the airports have been integrated, because the lack of such rail networks in the United States will make similar strategies infeasible at most U.S. airports.

The travel times from the four high-speed lines serving the new Frankfurt Airport ICE station will provide service that is actually competitive with the short-distance air trips that airport officials are trying to discourage. A 1-hr travel time from Frankfurt Airport to downtown Bonn is directly competitive with, and probably better than, the same trip by commuter aircraft. The traveler in western parts of Belgium may be induced to make an international trip through Charles de Gaulle Airport rather than through the Brussels airport, because of the rail travel times created by the TGV.

Whether the rider chooses a service with a fast line-haul journey with very few stops or a service with a slow line-haul journey with many points for transfer, the subject of distribution to the final destination needs to be addressed. While the top speed of the train is always of interest, it is the overall travel time of the entire journey that the customer considers

in choosing a travel mode. The designers of the system serving Copenhagen Airport have set a precedent for future systems integrating airport rail services into a national system whose overall quality is designed to meet the needs of the business traveler so often sought by the airlines.

ELEMENT 3: THE IMPORTANCE OF THE RAIL CONNECTION AT THE AIRPORT

This chapter reviews the importance of the quality of service provided by the train, the quality of the experience of boarding the train, and the quality of the experience of connecting to the rest of the transportation system in order to reach a final destination. For the potential rail customer arriving at an airport, key issues are the ease of locating the rail platform and the seamlessness of the connection to that rail platform. The creation of a high-quality, intermodal transfer facility often requires a high degree of cooperation between the airport designer and the rail system designer. To clarify the nature of the task of designing the transfer between rail and air, this section is presented in two parts: first, the task of designing a rail transfer facility at a new airport is reviewed; second, the issues of designing a rail transfer facility for an existing airport are reviewed. In each part, the difficulty of providing direct rail access is related to the configuration of the airport's passenger terminals.

Rail Connections at New Airports

Hong Kong

Few designers get the opportunity to plan an optimal intermodal system—a system characterized by the simultaneous design of the airport and the ground access services and viewed as one larger system. New airports have been built from the ground up in Paris, Dallas/Fort Worth, and Denver without achieving the integration of aviation and rail systems. Paris' Charles de Gaulle Airport was originally designed as a highly decentralized airport, with rail service to a town center but not to any of the terminals. By contrast, in both Oslo Airport and Hong Kong Airport, the designers were given the task of optimizing the relationship between the air and rail facilities. Hong Kong's airport can be viewed as one of the most aggressive attempts to date to integrate the rail station with the airport terminal structure.

Terminal Concept. From its earliest conceptualization in the Hong Kong airport master plan, the rail station was designed as a two-story structure (see Figure 5-19). For the enplaning cycle, the arriving train platform is located at the check-in level; for the deplaning cycle, the departing train platform is located at the baggage-claim level. The passenger is provided a free baggage cart from the baggage-claim carousel to the door of the train and does not change levels or experience any fare collection equipment.



Photo: Matthew A. Coogan

Figure 5-19. In Hong Kong, enplaning passengers connect from the rail on the upper bridge, while deplaning passengers connect to rail on the lower bridge.

The passenger flows in the air terminal have been designed to distribute passengers evenly over the cars of the train. Although the air terminal is more than 1,000 ft in length, the rail platform has been configured to be parallel to (as opposed to perpendicular to) the length of the airport. On the deplaning level, the airport passenger exits either at the northern arrival hall or at the southern arrival hall several hundred feet away. For each half of the airport, there is a simple, direct path to the train. Those passengers from the southern arrival hall are directed to the southern segment of the train, those from the northern arrival hall to the northern segment—this arrangement evenly distributes passengers through the length of the train. This pattern of locating the long, linear rail platform of the train parallel to the linear form of the air terminal was first applied in the Frankfurt airport, which has three points of access to the platform. The rail platforms at most airports, such as in Oslo and Munich, are configured perpendicular to the terminal; with just one point of access, passengers tend to “bunch” onto the nearest cars.

Having all the trains leave from one terminal station has certain operating advantages. Like the Gatwick Express, the Hong Kong station is operated so that there is always a train waiting at the platform. From the moment the passenger enters the rail station platform, he or she may start selecting a seat, stowing baggage, and so forth. Large electronic signs state exactly how many minutes remain before the departure of the train. In general, the task of providing simple graphic directions to the passenger is easier when there is only one rail station.

The Seamless Connection. MTRC has succeeded in making the path from the baggage claim to the train as seamless as possible. Personnel representing the Airport Express Line are located at the doorway between the customs clearance hall and the arrivals hall. Ticket booths and automated machines are located in the arrivals hall on the path from customs clearance to the rail platform.

The airport rail station has been designed without any fare collection equipment, even though entrance to every other station in the rail transit system requires that a ticket be inserted into a turnstile. The passenger merely uses the ticket to get out of the station when he or she has reached his or her destination. Every passenger is expected to have a ticket, but there is a fail-safe procedure in the event that a passenger does not have a ticket. Any passenger approaching the outbound turnstiles at the destination station without a ticket is forced to pay the highest fare on the system, which is the fare to the airport. Staff at all stations are trained to be polite to anyone who looks like an airline passenger and to arrange for a ticket sale at that point. Thus, there are no impediments between the arrival hall and boarding the train. The on-board staff members do not sell tickets.

Just before the arrival of the trains from downtown, the staff of the Airport Express distribute empty baggage carts along the length of the platform. Thus, when the doors of the train open, the rider sees a supply of available, free baggage carts immediately on his or her path into the air terminal.

Dealing with Expansion. The air terminal serving the first 40 gates of the Hong Kong airport is located immediately to the east of the two-level rail station. When the number of airport gates has more than doubled, a second air terminal will be built immediately to the west of the rail station. When the airport is fully built out, the walking distance from the train, through the check-in, and down to the underground people mover will be the same for both terminals. Thus, all 100 gates of the ultimate build-out will be served by a single rail station.

Oslo

In terms of an architectural concept for an airport–rail connection, the layout of Oslo’s airport is more traditional, with the rail platforms located immediately below the arrivals hall. Figure 5-20 shows the walk from the arrival hall (labeled ②) to escalators and elevators (labeled ①) that serve the train platforms immediately below. All trains depart from these platforms, including the dedicated Oslo Airport Express, the

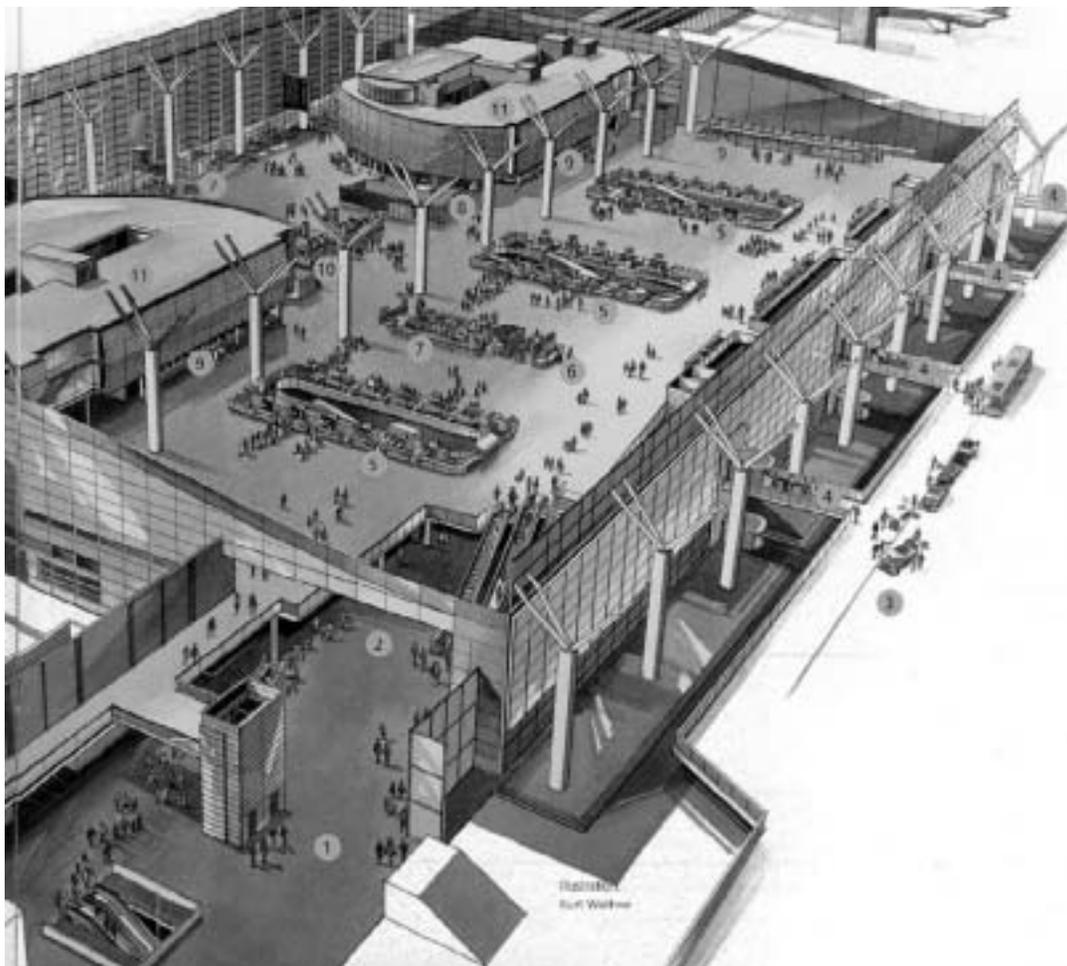


Figure 5-20. Escalators and elevators connect the arrival hall to the trains below.

SOURCE: Oslo Airport at Gardermoen.

national intercity rail, and local trains. The direct distance between the arrival hall and the rail platform is actually shorter at the Oslo airport than in the Hong Kong airport. However, in terms of ease of access, each change of level is a matter of some concern to those passengers with baggage, whether they have a baggage trolley or not. Similar “basement” locations at a centralized terminal are used in most European air rail stations.

The layout for the rail station is highly unusual, making the connection to the train as seamless and unencumbered as possible. The four tracks are laid out so that the passenger waiting for a departing Oslo Express train waits only on one center platform, which is served by two tracks. In a layout used in most airport people-mover shuttle configurations, each of the two arriving trains is also served by a separate outside platform. In this configuration, the arriving train always opens the outer doors first, sending the exiting passengers onto the exterior platforms; then the inner doors are opened for the new passengers to board the empty train. Although this is a common design for people movers, most rail station designs allow only one platform per track. The flow from terminal arrival hall to departing train is accomplished with absolutely minimized interference, with the luxury of providing separate graphic content for enplaning and deplaning passengers.

The expansion plan for Oslo Airport calls for the creation of a new midfield concourse, which will be served by the existing landside terminal.

New Airports with Difficult Connections: Charles de Gaulle

Not all airports that are built from a “green field” have easy connections for major rail investment. The original concept for Charles de Gaulle Airport proposed a series of terminals, architecturally modeled after Terminal 1, located in a highly decentralized format around a town center, where the original rail station is located. A people-mover loop would have connected as many as eight of these unit terminals. In the 1990s, a new vision was developed: Terminal 2 is directly adjacent to the new rail terminal, which provides service to both local and national lines. As shown in Figure 5-21, the long-term plan of the airport calls for the construction of two separate people movers: one to connect the new rail center with the original Terminal 1, and a second to connect the new rail center to the new boarding areas within Terminal 2.

Although the ultimate introduction of the automated people mover will help the transfer process from Terminal 1 to the TGV rail station, the connection is highly indirect, giving a distinct travel advantage to travelers using automobiles.

Adding the Rail Station to Older Airports

Retrofitting an Existing Airport: Zurich

Most public transportation planners, whether within or outside the United States, do not get the luxury of starting from a

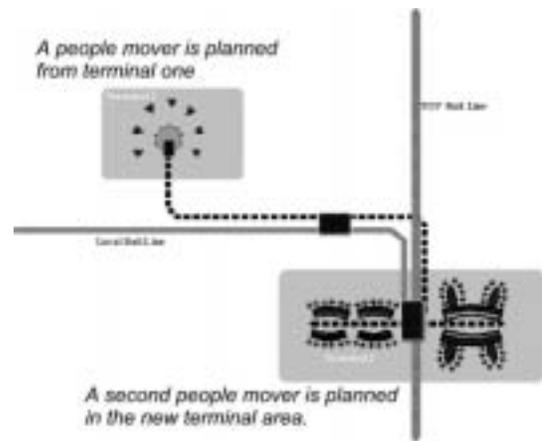


Figure 5-21. Two separate people-mover systems will be required to connect the Charles de Gaulle air terminals with the primary airport rail station.

SOURCE: Matthew A. Coogan.

clean slate with the simultaneous implementation of a new airport and a new transit line. In most cases, the design challenge is to take a rail line into an airport that is largely developed, which is a different challenge than that experienced in Oslo or Hong Kong. The airport rail station in Zurich can be used as an example, as it was built into a working airport and is now being rebuilt to provide higher standards for the rail user. The rail alignment on the upper right of Figure 5-22 shows how the

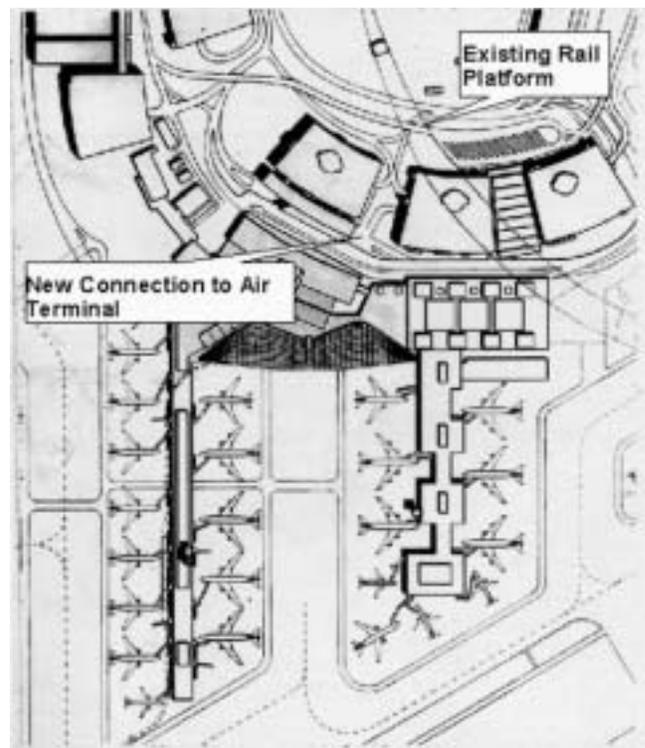


Figure 5-22. A new connection to the air terminal complex will be built in Zurich.

SOURCE: Zurich Airport, 1999.

alignment missed the older portion of the airport (the terminal structure on the left) and was coordinated with the construction of a new terminal (on the right side of the diagram). In the present facility, the pedestrian connections from the arrival hall to the basement rail line cause the traveler to walk up, over, and down, using a path over the airport access road, then down several stories to reach the lower level of the platform.

The needs of the rail user have guided the development of the expansion of the airport and the development of a mid-field airside concourse. Specifically, the mezzanine level of the rail station is being extended directly under the access road to allow direct access to the adjacent main terminal and a new air passenger departure center being constructed. A new set of escalators from the mezzanine level will replace the up-over-and-down path over the access road. A people mover connecting with the new mid-field concourse will leave from the same level as the mezzanine of the rail station. To serve the rail user better, 60 new airline check-in positions will be built on the mezzanine level of the rail station, minimizing the need for changes of level for those passengers carrying baggage.

Zurich Airport officials have committed to a public policy goal of 50 percent mode share to public transportation for air passengers and a 40 percent mode share for employees.

Retrofitting the Multiple Terminal Airport: Heathrow

Airports with multiple landside terminals will continue to be a challenge to the ground access designer. At present, both the London Underground and the Heathrow Express central terminal area stations are located in a plaza between Terminals 1, 2, and 3. The passenger gains access to the rail stations by long, poorly lit underground walkways.

The future layout of Heathrow poses a greater challenge, as the new Terminal 5 is not contiguous with any other terminal. Plans call for the Heathrow Express trainset to split in two at the first station, with the front section proceeding to Terminal 5 and the back section proceeding to Terminal 4. To accomplish a similar function, half of the Piccadilly Line service will be routed to Terminal 4 and half to Terminal 5, as shown in Figure 5-23.

Alternative Locations for Check-In at the Airport

Auxiliary Locations Within the Airport

In some cases, the connection between the airport terminal and the rail line will pose new design challenges. Even in

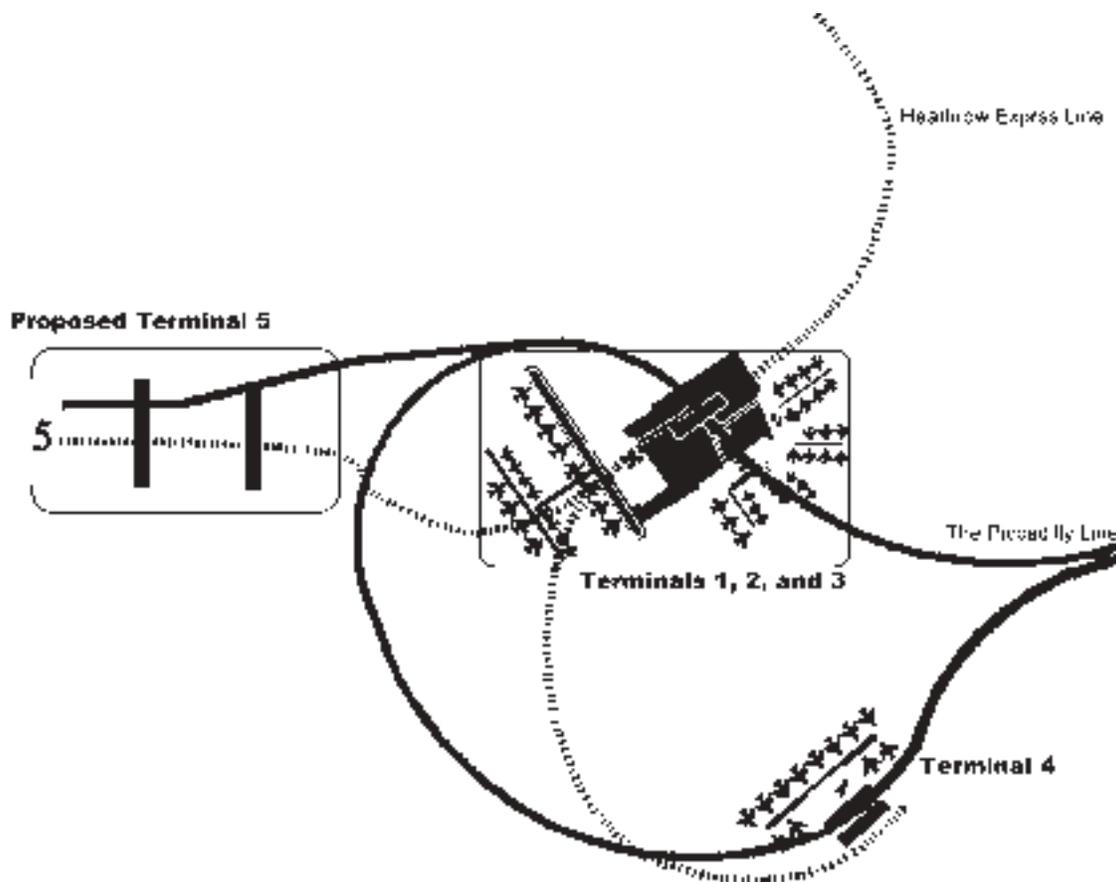


Figure 5-23. Heathrow Airport will have three major terminal areas, making rail access a challenge.

SOURCE: Matthew A. Coogan.

the case in which the rail has been well integrated into a new terminal at the airport, there may be long walking distances involved in getting to the plane. At Copenhagen Airport, the new Terminal 3 complex is directly connected to the new rail line, but walking distances to the other terminals are still a problem. To address the needs of the rail user with cumbersome baggage approaching the airport, an additional check-in facility that serves all the flights of the airport has been placed in the lobby of the rail station (Figure 5-24). Since the airport's opening in 1982, Munich travelers departing with Lufthansa have had the benefit of a special check-in area located immediately in the mezzanine lobby of the rail station. Now, with Lufthansa providing check-in services for all airlines of the Star Alliance, other airlines are offering check-in services at the mezzanine lobby of the rail station. As noted above, the reconstruction of the Zurich airport will add some 60 check-in positions at the mezzanine level of the rail station.

The Check-In Facility in the Airport Rail Station

Each of these auxiliary check-in locations is located within the airport in order to improve service for the passenger continuing to the gate on foot. The concept is being applied on a larger scale with people movers in several new projects at German airports. In Frankfurt, a second airport rail station serving the ICE high-speed rail system has been constructed. Because of the complexity of routing four new high-speed rail lines, it was impossible to expand the existing station, which is located in the basement of Terminal 1. The new rail station is located across a major expressway, which is not convenient for the air passenger who is going to either Terminal 1 or Terminal 2. The new rail station location required an extensive program to improve the quality of access to the air terminals. In the final design, a people mover will connect the new station and adjacent hotel and convention center com-



Photo: Matthew A. Coogan

Figure 5-24. A check-in station (left) is located in the rail station at Copenhagen Airport.

plex with the new Terminal 2; moving walks over bridges will connect the new station to the original Terminal 1.

To aid the provision of the seamless transfer, the German Railway has built a significant complex within the rail station itself. This includes the construction of a frequent traveler lounge immediately above the tracks and a full-scale airline check-in facility as part of the rail station complex (Figure 5-25). In a highly unusual design strategy, airline passengers with through-tickets on the rail system will claim their airline baggage at the rail station; customs clearance is located there.

The concept of a major check-in facility located at the point of transfer for the rail passenger is a common theme in developing plans for AirRail terminals in Germany. At Düsseldorf Airport, it was determined that it would not be cost-effective to reroute the major high-speed rail line off of its alignment and into the airport terminal area, a distance of 1 mi. Instead, a new people mover is being built to connect the air terminal with the existing alignment of the high-speed rail system. Figure 5-26 shows the point of transfer between the high-speed rail service and the airport people mover, where a full-scale airline check-in facility will be built at the mezzanine level of the train station.

Moving the Air Terminal to the Airport Rail Station

In the examples of the Frankfurt and Düsseldorf Airports, the designers have added a second, or auxiliary, check-in facility that is convenient for those passengers who access the airport by rail. A more aggressive strategy is being implemented at the Leipzig/Halle airport, in the former East Germany. Here, all landside terminal functions (check-in, baggage claim, etc.) will be relocated to the mezzanine level of the new high-speed rail station (described as the "Central building" in Figure 5-27).



Figure 5-25. The new rail station in Frankfurt International Airport has airline check-in services in the rail station lobby.

SOURCE: Frankfurt Airport.



Figure 5-26. Airline check-in functions occur in the new Düsseldorf International Airport rail station.

SOURCE: Düsseldorf International Airport website (www.duesseldorf-international.de/).

The existing airport complex is located to the south of the rail line; the next phase of development will occur on the north side of the rail line. The landside services of the existing airport are being moved to a “bridge” over the high-speed rail line, which will become the central element of the new airport. The architectural expression of this multimodal terminal, located over the rail and highway, is shown in Figure 5-28.

Leipzig is not the only airport to propose relocating the air terminal complex to the main line rail station. The long-term plan for London Luton Airport, to the west of London, calls for the landside functions of the existing airport to be relocated approximately 1 mi away to a new intermodal terminal that will be built over the main line tracks to London. A people mover would then connect the new landside air terminal with the airside concourses. The plan has a series of phases; initially, the check-in functions at the rail station will be linked to the existing airport terminals by bus.

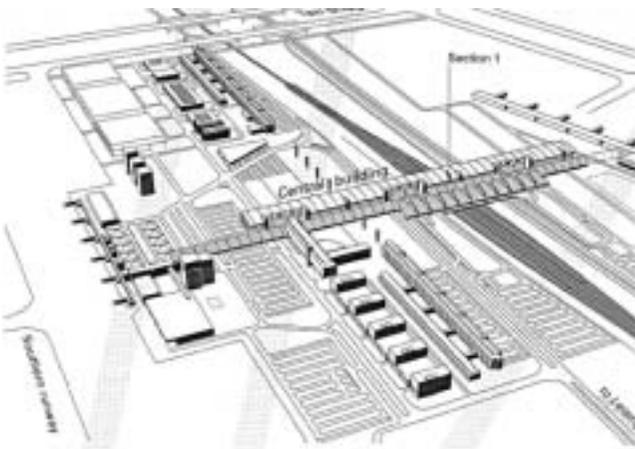


Figure 5-27. The airport passenger terminal at Leipzig/Halle Airport will be relocated to the new high-speed rail station.

SOURCE: Leipzig/Halle Airport.



Figure 5-28. An architectural rendering of the Leipzig/Halle air terminal at the high-speed rail station.

SOURCE: Düsseldorf International Airport website (www.duesseldorf-international.de/).

Because Luton Airport is located on a main commuter rail line, existing express service links the Luton train station with London’s Kings Cross Station in about 20 min. Kings Cross Station will become a critical international interchange point when both the “Eurostar” Chunnel service and a new Heathrow Express service are routed there later in the decade.

Lessons Learned: Alternative Check-In Locations at the Airport

For many U.S. airports, it will be difficult to develop rail service to all airport passenger terminals—a design characteristic of most of the successful airports in this study. Many U.S. airports plan some form of people mover to link the terminals with rail services. Others are considering the creation of “ground transportation centers,” from which all forms of public transportation would be dispatched. The emerging pattern of auxiliary check-in services in Germany and in other countries is relevant to the design and planning of these U.S. transfer facilities. With the reconstruction of Reagan National Airport, US Airways has added an auxiliary check-in position at the terminal entrance serving the pedestrian bridge connecting from both the WMATA Metro station and the principal parking garage. Placement of this check-in desk at the bridge level of the terminal eliminates the need for the rail transit user to proceed up one level to the main check-in area and then proceed back down to the departure concourse. In Hartsfield Atlanta Airport, Delta Air Lines has opened a check-in facility at the level of the rail station.

At the present time, the potential of baggage check-in services at Jamaica Station is being explored to support the new rail connector service to JFK Airport. Designers of Miami’s Intermodal Center are examining the option of a second location for airline baggage claim, inside the new intermodal transfer facility; this facility is similar in concept to the facility being built as part of the new Frankfurt Airport ICE rail station. The option of adding check-in service at Newark Air-

port's new rail station serving New Jersey Transit rail services has been preserved in the existing designs.

In the successful rail systems, a wide variety of strategies are being developed to help the user who accesses the airport by rail. From the 60 new check-in stations at the Zurich Airport rail station, to the ambitious plans for airline baggage claim and customs clearance at the Frankfurt Airport rail station, to the plans to move airport terminal functions to the rail stations in Leipzig and Luton, the successful rail systems are using alternative check-in strategies to provide seamless transfer.

The Role of Airport Configuration

Some forms of airport configuration are easier to serve directly by rail than are other forms of configuration. At the extreme ends of the spectrum, the relationship between airport configuration and ground access systems can be observed. There are currently no plans to take any form of rail service to Charles de Gaulle Airport's existing Terminal 1, which was originally conceived as an element of a highly decentralized airport. London's Heathrow Airport will operate five separate terminals, clustered as 1, 2, 3, (the central terminal area) and 4 and 5. In the United States, New York's JFK Airport will require nine stations in order to serve adequately all the airport activity areas.

At the other end of the spectrum, all services from Oslo Airport and Hong Kong Airport leave from one transfer point, which is located next to baggage claim or customs clearance. Airports with highly centralized landside facilities appear in Zurich, Geneva, Oslo, Stansted, Hong Kong, and Milan. Most airports built from the ground up are now being planned to utilize a single landside terminal rather than multiple unit terminals; the new Berlin Brandenburg International Airport is an example of this.

As shown in Table 5-4, most of the airports with the highest mode shares to rail are characterized by direct rail con-

nections to a single, centralized point of transfer to a compact airport landside terminal. Of the top 10, only Tokyo Narita and Heathrow Airports have adopted a two-station strategy. Within our sample of 14 airports, only 2 rely on either a bus or a people mover to get from the train to major air terminals; both airports are in Paris, and both rank near the lowest in mode share attracted to rail.

Lessons Learned: Quality of the Rail Connection at the Airport

The Importance of the Seamless Connection

The successful rail systems provide a wide variety of concepts of value to the U.S. practitioner seeking to design an effective connection between the airport terminal and the rail platform. Perhaps more than any other transfer facility in the world, the Hong Kong Airport rail station demonstrates the attention to detail desired by the air passenger. The path from baggage claim to the rail vehicle should be as direct as possible, even if this is difficult to accomplish. The level of facility integration at the Hong Kong airport can be considered a goal to be sought by designers in the future. The rider, carrying baggage, walks from the customs clearance point to the train without changing levels and without ever using turnstiles or any form of impediment. Similarly, the simplicity of the pedestrian path from the Oslo airport's arrival hall to the common departure platform represents a design attribute to be emulated.

The available data reveal that good integrated connections at the airport are correlated with successful mode share, but that good connections are a necessary but not sufficient element of a total strategy. The terminal design with the highest quality for the rail user—that of the Hong Kong airport—captures about 21 percent of its market, placing the airport in the top 10 in terms of market share, but lower than the top 5, each of which attracts more than 30 percent mode share.

The case studies presented in Chapter 4, however, suggest that many airports have neither the centralized characteristics of the Hong Kong airport nor the decentralized characteristics of Dallas/Fort Worth Airport. Most can be categorized as somewhere in the middle. Expanded air traffic has caused the creation of multiple landside air terminals in airports originally designed to operate from one terminal, including Tokyo Narita, London Gatwick, and Frankfurt Airports. Most airports in the sample grew incrementally, with one rail facility now expected to serve several terminal buildings, as in the Brussels and Copenhagen airports. For each of these incrementally developed configurations, solutions have to be designed to help the passenger connect with the rail vehicle as seamlessly as possible.

ELEMENT 4: THE IMPORTANCE OF A STRATEGY FOR BAGGAGE

Creating a strategy to deal with the problem of baggage is a challenge for all designers of airport ground access systems.

TABLE 5-4 Single-terminal versus multiterminal airports

Airport	Rail mode share	Number of stops at airport	Compact terminal complex
Oslo	43	One	Yes
Tokyo Narita	36	Two	No
Geneva	35	One	Yes
Zurich	34	One	Yes
Munich	31	One	Yes
Frankfurt	27	Two	One
Stansted	27	One	Yes
Amsterdam	25	One	Yes
London Heathrow	25	Two	No
Hong Kong	24	One	Yes
London Gatwick	20	One	Partial
Brussels	16	One	Partial
Paris de Gaulle	15	Two	No
Paris Orly	6	No direct	No

The responses to the problem range from doing nothing to developing elaborate, full-service off-site check-in facilities. However, a variety of lower-cost options are being tested around the world. To explore the issue in some detail, the solutions for baggage handling can be examined in terms of two major categories: (1) full-service downtown check-in centers and (2) national schemes to deal with many off-site check-in opportunities.

Full-Service Downtown Check-In Centers

The downtown check-in center at London's Paddington Station can be used as a best case practice for off-site check-in facilities. The Paddington Station check-in system is the newest in the field and can be compared with the experience at London Gatwick Airport and in Hong Kong.

Heathrow

At Paddington Station, a new airport check-in center, complete with food services and concessions, has been built as part of the Heathrow Express project (see Figure 5-29).

The Heathrow Express operates on two tracks, tracks 6 and 7, located in the center of Paddington Station. A total of 28 check-in stations have been built as shown in Figure 5-30. Bags must be checked in 120 min before flight time, which is the same time as is required at the airport for international flights, but somewhat longer than is required for domestic flights.

Baggage is routed onto a conveyor belt running under the platform. Between the baggage check-in facility and the front of the train, a long secure tunnel has been built (see Figure 5-31).

At a secure location at the front of the train, the baggage belt rises to the level of the platform, where each bag has its



Photo: Matthew A. Coogan

Figure 5-30. The bag is checked in.

bar code read and is entered into the tracking system (Figure 5-32). Bags are placed in a container, of which there is one for each of the four terminals at Heathrow Airport. The container is then padlocked (Figure 5-33). At this point, the computer system has tracked the placement of each bag into each container.

The container system is not automated, and the container is pushed by the attendant onto the baggage car, which is located immediately behind the cab of the airport-bound train (Figure 5-34). As each container leaves the handling area at Heathrow Airport, it is scanned into the system, which then has a record of the time when each bag has been transferred from the rail system. Containers are carried to each of the four terminals by four airport trucks. At the specific terminal, the bags are entered into the terminal baggage system with other bags being checked in at the terminal.



Photo: Matthew A. Coogan

Figure 5-29. London's Paddington Station is the newest downtown check-in center.



Photo: Matthew A. Coogan

Figure 5-31. The bag is sent on a conveyor belt under the platform to the head of the train.



Photo: Matthew A. Coogan

Figure 5-32. The bag is scanned at the platform level and loaded into a container.

The procedure of unloading the empty containers and loading the baggage takes place over the full cycle of the train's waiting time at the downtown station, which is currently 15 min. (It is operating policy that there is always a train waiting at the downtown station.) A recent analysis by the International Air Rail Organisation of the baggage system for Heathrow Airport reported that the system is staffed with 15 employees: 3 assigned to the conveyer, 2 loading the trains, 5 unloading the trains, and 5 distributing the bags at Heathrow.

Hong Kong

MTRC provides downtown check-in service for its Airport Express service at two locations: the downtown Central and Kowloon Stations. The operation of the baggage-handling system has been so efficient that travelers can now check bags in at the downtown Central Station only 90 min before



Photo: Matthew A. Coogan

Figure 5-33. The container is locked.



Photo: Matthew A. Coogan

Figure 5-34. The container is pushed onto the train.

flight departure—the same time the traveler would have been required to be at the airport.

Hong Kong Airport Express officials report that 53 percent of those passengers using the trains now use the check-in service, with peak levels as high as 70 percent. Although these numbers are high, it can be noted that the Hong Kong airport is exclusively an international airport, with most major destinations several hours away. Thus, trip duration tends to be longer, and the percentage of travelers checking bags is very high (50).

The design of the downtown Central Station can be compared with design in Paddington Station. To keep running times to a minimum, the Kowloon Station loading operation must be completed within the 60-second dwell time established for the station. Because of these constraints, the designers of the Hong Kong system specified an automated, mechanized system to get the containers on and off of the train (see Figure 5-35).

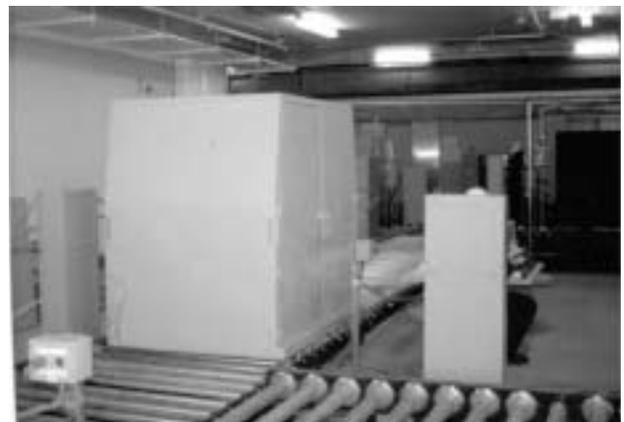


Photo: Matthew A. Coogan

Figure 5-35. The container system in Hong Kong is automated.

The layout of Hong Kong's Central Station is fundamentally different than that of the Heathrow Express at Paddington Station. Because the Hong Kong designers were starting from scratch as opposed to retrofitting an historic structure, the design of Central Station allows for the passenger check-in hall to be located immediately above the front end of the train on the platform below. Thus, baggage checked in at ground level is sent on two spiral ramps to the baggage transfer room immediately below (Figure 5-36). At the baggage transfer room, bags are placed in containers, which are designed to be automated. During the first months of operation, Hong Kong Express management decided to postpone the startup of the automated system. Staff attendants pushed the containers on and off the baggage car in a manner similar to the permanent system for Heathrow.

The baggage transfers at the Heathrow and Hong Kong downtown stations occur at a secure point on the platform, an area where the public cannot gain access. Systems operating in Switzerland and for the Gatwick Express must transfer the baggage on a working platform.

Gatwick

The baggage car of the Gatwick Express is located on the first car of the train on the inbound direction. Thus, all passengers gaining access to the train must pass by the loading operation, as shown in Figure 5-37. Heathrow Express avoided this configuration with the construction of the conveyor belt tunnel under the platforms.

Passenger check-in occurs at a second-story location for British Airways and at the platform level for American Airlines. The upper level check-in facility, which is dedicated to British Airways, has 16 desks and is served by an elaborate taxi drop-off/pick-up area that is conveniently located off of the street. Some 300,000 Gatwick passengers use the British Airways facility at Victoria Station. Bags must



Photo: Matthew A. Coogan

Figure 5-36. The Hong Kong transfer facility is directly under the downtown check-in area.



Photo: Matthew A. Coogan

Figure 5-37. A traditional baggage car is used in the Gatwick Express.

be checked in 120 min prior to plane departure. See Figure 5-38.

Because those passengers checking in at the American Airlines platform level have direct contact with the departing train, this platform-level location is seen by local officials as the model for later alterations to the station. Officials are now examining plans to consolidate the operations at a platform-level location.

Gatwick officials report that about 25 percent of rail travelers making long-distance flights use the downtown check-in service, but few of the domestic flyers use the service.

Osaka's Kansai

Another example of downtown check-in services is the service from Kansai International Airport to the Namba downtown air terminal in Osaka, the only airport check-in rail sta-



Photo: Matthew A. Coogan

Figure 5-38. American Airlines uses a rolling container at Victoria Station.

tion in Japan. Express service is operated every ½ hr, utilizing both dedicated-express and local express services.

Kuala Lumpur

Of all the airport off-site check-in schemes being developed, only Malaysia's Kuala Lumpur International Airport is proposing off-site baggage claim for their downtown terminal, located at the Kuala Lumpur City Air Terminal at KL Sentral Station. The project proposes to establish the City Air Terminal at Sentral as a separate three-letter International Air Transport Association (IATA) code, allowing passengers to check their baggage to the city rather than to the airport. This concept was examined in depth in the development of the Hong Kong system and again for the Heathrow Express. One factor of concern to the Hong Kong designers was the amount of space needed by a full-scale baggage-claim area. Another concern has been the possibility that travelers will inaccurately specify the actual destination, whether at the time of ticket purchase or at the moment of check-in. As noted earlier in this section, bags checked to rail stations in Germany will be routed to the auxiliary baggage-claim area in the new Frankfurt Airport high-speed rail station, which presents something of precedent for the ambitious Kuala Lumpur proposal. (A similar concept is under consideration for the through routing of bags in the Miami Intermodal Center.)

Munich

Initially, planners of the new Munich Airport had hoped to integrate a downtown check-in concept with the major public ground access mode, the S-Bahn. Toward this end, a check-in station operated by Lufthansa Airlines was inaugurated in Hauptbahnhof Station. However, there was no agreement on the question of who would pay for the baggage-handling space for each of the S-Bahn trains serving the airport. The transit agency took the position that it needed the capacity for its primary function—serving passengers. A compromise was reached, and the baggage was carried to the airport on the airport bus, which was routed to Hauptbahnhof Station. The check-in facility was small, with only two check-in desks (see Figure 5-39). Lufthansa abandoned the operation in the mid- 1990s, replacing it with an automated check-in machine for those passengers with only carry-on baggage.

Lessons Learned: Full-Service Downtown Check-In Centers

Many U.S. cities, including St. Louis, Atlanta, Chicago, and New York, have considered the construction of major down-



Photo: Matthew A. Coogan

Figure 5-39. Lufthansa offered downtown baggage check-in at Munich's Central Station.

town check-in terminals. So far, in the international experience, only London, Osaka, and Hong Kong have made the concept work for rail systems. Using buses, there is a long tradition in Scandinavia of downtown check-in; Tokyo Narita Airport is served by a downtown check-in center for luxury bus operations.

This full-service downtown check-in strategy is based on the concept that the airlines will provide full services at the off-site location, in addition to staffing the check-in site at the airport. As discussed below, alternative concepts are now being developed in which third parties who are not employed by the airlines are authorized to check baggage through to its final destination and, in some but not all cases, to provide airline boarding passes.

The key element in adopting a full-service check-in operation is the effective cost allocation of providing the service. At the Hong Kong airport, little progress was made in developing the concept until a financial deal was reached with the dominant carrier for the airport. Then, the competing airlines realized they had to provide similar services. Even with this leadership from a major airline, the cost negotiations between the transit agency and the airlines proved to be particularly difficult. Ultimately, it was determined that the transit agency had the most to gain from the operation, and it became a financial contributor to the success of the operation.

At Heathrow Airport, a compromise was reached in which the airlines pay rent (to the landlord of the building) for their check-in stations (Figure 5-40) and provide distribution services at the airport. The cost of handling bags on and off the train is considered part of the operating cost of the Heathrow Express. The U.S. practitioner should not underestimate the complexity of the operation, based on the elaborate mechanism developed for the Heathrow Express. Issues of security and the tracking of baggage location through bar code verifications resulted in a significant cost for both capital and operation of the service.



Photo: Matthew A. Coogan

Figure 5-40. The airlines pay rent to Railtrack, the owner of Paddington Station.

Requirements of the Downtown Check-In Terminal

The design of the downtown terminal must address the specialized needs of the air traveler. The Heathrow Express terminal at Paddington Station and Central Station and Kowloon Station terminals for the Hong Kong Airport Express provide dedicated buses to distribute passengers to local hotels. All three terminals have active programs to maximize the efficiency of the transfer to taxis.

Of those passengers arriving at Paddington Station, 50 percent of rail passengers proceed on by taxi; 45 percent by Underground; and 5 percent by other means, including walking. The ridership on the dedicated hotel distributor bus has been a problem. In order to appeal to the business market, a good taxi connection has been a high priority. At peak hours, primarily with the arrival of business passengers in the morning, there was a problem with taxi availability, so the managers of the Heathrow Express established a shared-ride system in cooperation with the taxicab operators. The taxi pick-up area is shown in Figure 5-41.

The designers of the Hong Kong Express have paid considerable attention to the quality of transfer between the rail platform and the taxi. At Central Station, the taxi deposits the departing traveler at ground level, immediately in front of the check-in desks. The arriving passenger arrives one level below, where the taxi pick-up lane is located immediately across from the train platform level. The passengers wait inside the terminal at individual gates for the taxis to arrive, without ever waiting outdoors.

The design for the taxi interface at the downtown Kowloon Station is shown in Figure 5-42. As shown in the diagram, each of the two “finger piers” of the station is designed to support 10 taxi-loading locations at once, all from one air-conditioned



Photo: Matthew A. Coogan

Figure 5-41. The taxi stand at Paddington Station can dispatch eight cabs at a time.

waiting and queuing area. This taxi loading facility is unique in the world.

The managers of the Oslo Express have developed a joint ticket, which is good both for the train and then for the completion of the journey by taxi. Thus, the user buying an airline ticket can purchase a multimodal ticket with a single integrated fare. Such a program is also under development in support of the Arlanda Express train in Stockholm.

Strategies for National Off-Site Check-In

While full-service downtown check-in facilities staffed by airport personnel are in operation in two cities, alternative strategies that encourage off-site check-in at smaller terminals are being developed in Switzerland, France, and Germany and are under exploration in the Netherlands.

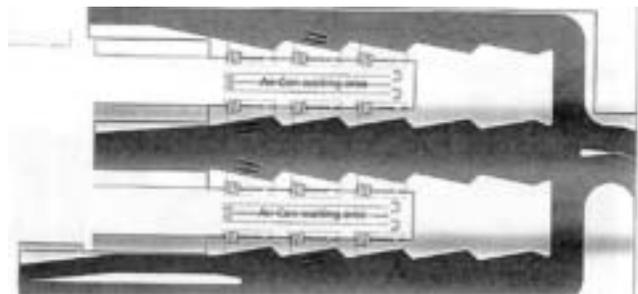


Figure 5-42. This Hong Kong taxi dispatching point could dispatch 20 taxis at a time, with all riders waiting in the air-conditioned space.

SOURCE: Mass Transit Railway Corporation.

National Baggage Check-In: The Swiss Fly-Rail Baggage System

The concept of a national system for off-site baggage check-in is fundamentally different from the three existing downtown check-in centers serving Heathrow, Gatwick, and Hong Kong Airports or the luxury bus service serving Tokyo Narita Airport. Each of these downtown check-in terminals is staffed by airline representatives who take the responsibility for accepting baggage and issuing boarding passes. When the concept is expanded to dozens—or in the case of Switzerland, hundreds—of off-site locations, it becomes impossible to expect multiple airline companies, or even one airline company, to provide the staff at each of the off-site locations. Alternatively, a partnership with the railroads has to be built, in which the railroads are empowered to take certain actions in the name of the airlines. The Swiss Fly-Rail Baggage system has been in place for two decades; recent developments in Germany and France are refining the concept for wider application.

As described in Chapter 4, the Swiss Fly-Rail Baggage system is provided by the national railway rather than by the dominant airline. The Swiss Federal Railway charges Fr 20 (US \$13) for each bag. Although the nationwide system operates from 116 locations to both Zurich and Geneva, about 80 percent of the bags are transferred through Zurich. It has been estimated that about 6 percent of the air passengers leaving Zurich Airport have made use of the system. In 1990, 275,000 bags were checked in for departure from Zurich Airport, and 100,000 bags were checked through to rail stations upon arrival at Zurich Airport. These incoming bags use a customs declaration tag that is signed when the bag is checked for its flight to Switzerland.

Although most of the examples described in the section above concerned a dominant central city check-in center, the opposite seems to be true in Switzerland. Of those bags checked through Zurich Airport, fewer than 5 percent came from the Zurich rail station. By contrast, 17 percent of the bags at Zurich came from Bern, the capital city. More than 10 percent of the bags came from major resort areas.

Mechanically, the process uses the conventional baggage system of the Swiss Federal Railways and uses the same baggage cars as other carried cargo. Each bag is taped shut with a distinctive reflective tape or sealed in a plastic bag to discourage tampering.

The German Approach to Integrated Baggage

In the context of the integration of airport access services with national rail systems, baggage strategy is just a part of a larger commitment between the German Railways and Lufthansa Airlines to replace certain local airline flights with high-quality integrated rail connections. In July 1998,

Deutsche Bahn and Lufthansa Airlines signed a Memorandum of Understanding that stated that the airline will terminate feeder flights to Frankfurt from Düsseldorf, Cologne, and Stuttgart, but only if certain standards of seamless operation have been attained. The basic attribute agreed upon is that actual travel times by rail will be no longer than the present times by feeder aircraft. The memorandum calls for “full check-in from the train station of departure through to the destination airport, and uninterrupted baggage transfer from the train station of departure to the destination airport.”

Yet to be resolved is the fact that, at present, the German rail high-speed equipment—the ICE train—does not have separate baggage-storage capacity.

In order to test the integrated baggage concept, a trial operation was started in June 1998 at the city of Saarbrücken. Check-in and boarding pass operations occur at the rail station, and the Deutsche Bahn rail staff place baggage in a container, which is then locked. The container is removed from the train by Frankfurt airport staff who place it into the airport’s internal baggage distribution system. Lufthansa looks at the Saarbrücken experiment as a test case for wider applications throughout Germany.

In another limited application test, travelers near the rail stations at Düsseldorf, Cologne, Bonn, Würzburg, and Nuremberg can check their bags at the local station through Frankfurt Airport between the hours of 7 P.M. and 9 P.M.

Other Approaches to Baggage Handling

For most passengers accessing the airport by rail, baggage is carried on board, even when elaborate alternatives are offered in London and Switzerland. (The Hong Kong experience may be the exception.) For those passengers carrying their bags onto the rail vehicle, the availability of adequate storage areas is a key factor. The Heathrow Express has large storage areas at centrally located doors. The storage bins are built out of transparent plastics, allowing the traveler to see the bags in the storage area (see Figure 5-43). The bins are visible from some seats, but not from all.

The designers of the Oslo Airport Express, while still hoping for downtown check-in, have incorporated an unusual design feature in the new trainsets. A major baggage-storage area is placed in the center of the aisle, at the entry doors. All the seats on the vehicle are designed to allow viewing of baggage, as shown in Figure 5-44. Norwegian rail researchers found that fear of losing baggage was a major concern of passengers and designed this unusual solution.

For many years, several Scandinavian cities have offered a variety of off-site check-in services. At the present time, air travelers in business class are offered hotel check-in services at many SAS Radisson Hotels. For these users, baggage is manually placed in the airport bus and manually taken off the bus at the airport. Other hotel chains provide similar services.



Photo: Matthew A. Coogan

Figure 5-43. Baggage racks on the Heathrow Express are transparent.

Likewise, many cruise ship lines have developed innovative off-site airline check-in strategies.

Lessons Learned: Handling Baggage

Baggage-handling strategies designed to improve the trip quality for users of public transportation services to the airport remain one of the most controversial aspects of the subject of airport ground access.

Table 5-5 shows that, while the existence of off-site check-in is a positive attribute in Hong Kong and London, many of the successful systems have achieved high market share without the use of an off-site baggage strategy. Many rail systems use standard intercity rail equipment, which is designed to accommodate baggage in its normal service.



Figure 5-44. All seats face the baggage-storage racks on the Oslo Airport Express trains.

SOURCE: Adtranz.

TABLE 5-5 Strategies for handling baggage

Airport	Rail mode share	Off-site baggage aid	On vehicle provision
Oslo	43	No	Yes
Tokyo Narita	36	Bus only	Yes
Geneva	35	Yes	Intercity
Zurich	34	Yes	Intercity
Munich	31	No	No
Frankfurt	27	No	Yes/No
Stansted	27	No	Yes
Amsterdam	27	No	Intercity
London Heathrow	25	Yes	Yes/No
Hong Kong	24	Yes	Yes
London Gatwick	20	Yes	Yes
Paris de Gaulle	20	No	No
Brussels	16	No	Yes
Paris Orly	14	No	No

An off-site baggage strategy should be structured around the needs of the market. Historically, most passengers flying out of Hong Kong have been going to far distant locations, with “domestic” flights a contradiction in terms until the recent reunification with China. Long distances often correlate with longer trip duration, which correlates with more baggage. Similarly, the trip from distant towns in Switzerland may involve several train transfers and complex moves with large baggage, such as skis.

Other markets have other characteristics. At London’s Gatwick Airport, use of the off-site baggage check-in for domestic flights in the United Kingdom is rare, even though the system is well used for international flights. Of those passengers accessing Zurich Airport by rail, four of five have selected not to use the extra cost baggage-handling service.

The provision of full baggage services at off-site locations is expensive for the airlines. A British Airways official estimated that an off-site check-in center would not make sense with fewer than 100,000 users a year. In both of the two new major downtown check-in centers, financial arrangements have been worked out to split the costs between the airline (which is providing a desired service to their customers) and the rail company (which is charging a high fare with the intent of making a profit on the operation). Similarly, when the Munich transit agency was asked, in effect, to donate space on board its transit vehicles, the transit agency refused.

The German model for off-site check-in is also of interest. Although the issuing of boarding passes is done by automated equipment owned by the airlines, transporting baggage is the responsibility of the railroads and is undertaken by their employees. The test run of the German system at Saarbrücken uses containers that are very similar to those used in the Heathrow Express. A key concept, according to German planners involved in the implementation of their program, is the acceptance of third parties to process the baggage from the origin point to the airport. The shared use of employees who are already in place with established work assignments could lower

the incremental cost of managing baggage shipments. In this concept, the total cost for smaller operations might be significantly lower than for airline-managed operations.

Finally, the approach taken in Oslo, which will be repeated in Berlin, of providing specialized support facilities to the traveler who does carry baggage on the vehicle is worthy of note. Designers of the Oslo system, by way of example, worked

extensively on the design of new, lighter baggage trolleys capable of operating safely on escalators. Managers of Gatwick Airport allow baggage trolleys on board the people mover that connects the baggage-claim area of the new North Terminal with existing rail station at the original terminal. In short, a wide variety of strategies to deal with baggage are used in the successful airport rail services.

CHAPTER 6

NEW AND EMERGING TECHNOLOGIES FOR AIRPORT ACCESS

This chapter presents a review of recent transit industry developments that could affect the longer term options available for resolving airport ground access issues. The six areas in which the technologies of the transit industry and the aviation sector combine to enhance airport ground access are summarized below:

1. Advanced Traveler Information Systems (ATIS),
2. Technology for ride matching
3. Emerging bus technology,
4. Emerging rail technology,
5. Automated people-mover technology, and
6. Alternative strategies for off-site airport check-in.

ATIS: APPLICABILITY TO AIRPORT GROUND ACCESS

A key issue for the providers of airport ground access services is the dissemination of information about the services. A key issue for the traveler is to learn about the transit options available. A discussion of recent developments in the field of ATIS that can play an important role in providing such information about services to the potential user is provided in this section.

Three Phases of Information Dissemination

Recent literature on ATIS for the longer-distance trip has defined three time frames for dissemination of information: (1) at the time of trip planning, (2) at the time of trip commencement, and (3) while en route. Importantly, the traveler's need for information varies significantly as a function of the timing of the information request, as summarized below:

1. **At the time of trip planning.** Information about public ground access services could be made available to the traveler when the airline segment of the total trip is purchased. Because the airline ticket is usually reserved several days before commencement of the trip, the user needs to be provided with *static* information, usually about routes, schedules, and costs. Information for this phase is usually provided to the user by the airlines and travel agents.
2. **At the time of trip commencement.** In preparation for starting the trip, the traveler has a need for infor-

mation about conditions that would affect the circumstances of the trip. While route and schedule data are needed at the time of trip planning, *real-time* or *dynamic* information is needed at the time of trip commencement. At this phase, information about accidents or unusual changes in expected travel time is made available to the user. Information about a bad traffic jam in Boston, for example, might convince the user to take rapid transit rather than to drive through the Sumner Tunnel to access Boston-Logan Airport. News of an accident in the Queens Midtown Tunnel could be of value to a Manhattan traveler who had expected to take a taxi to JFK Airport; he or she now chooses to take the train to Jamaica Station. Information for this phase is usually provided via radio, telephone, and the Internet by regional information providers.

3. **While en route.** Once the longer-distance, intercity trip has begun, the traveler needs information along the way—usually in transfer terminals, but also within the moving vehicles. At this point, the needs of the traveler require highly accurate information, specific to a given gate, platform, or minute of departure. The role of transfer terminal management is key here. Travelers seeking information on connecting modes have a need for dynamic, real-time information about the timing and location of the public transit service. Information for this phase is usually provided by the operators of the terminals and the providers of the transportation services. See Figure 6-1.

Developments in information technology, organized in terms of these three categories of information needed by the traveler, are discussed below.

Information at the Time of Trip Planning

At the time of trip planning, the intercity traveler needs information about ground transportation options simultaneously with selection of the airline trip. A traveler going to the Los Angeles region, for example, may want ground connection information when selecting among the Los Angeles-area airports. The traveler is in need of information about the options available to a particular destination. In many cases, the traveler is offered essentially a list or compilation of schedule information, which is not enough information for travelers



Photo: Matthew A. Coogan

Figure 6-1. Both interactive itinerary planning and “next bus” schedule information are available at the Geneva airport rail station.

unfamiliar with the location of the destination or the transportation system.

At present, the information available to the traveler about ground transportation services at the destination end of the trip is often sporadic and incomplete. Currently, several implementation activities are under way for a wide variety of strategies to disseminate ground transportation information to passengers. These activities range from total integration of both information and ticketing to early attempts to provide information on local routes and schedules to travelers in a user-friendly format. In Germany and Denmark, the integration of airline tickets with connecting rail tickets is a mature program; in the United States, United Airlines has a successful program of through-ticketing for selected bus trip segments.

Integration of Ground Access Information with Airline Information

Several levels of integration of airline and connecting transit mode information are currently in operation. The most thorough integration of information incorporates the connecting mode data into the actual reservation system used by the airlines, called the computer reservation system (CRS). Much of the pioneering activity in this area has been undertaken over the past decades by Lufthansa German Airlines and Deutsche Bahn, the national railway. The first use of integrated information systems occurred when Lufthansa began operating rail service between Frankfurt Airport and Düsseldorf Airport, with service to Cologne and Bonn along the way. In this instance, Lufthansa was responsible for both air and rail operations. However, over time, the airline determined that it was more cost-effective to buy tickets on the regularly scheduled national railroad lines than to operate trains dedicated to airline passengers. In 1998, Lufthansa and Deutsche Bahn announced an agreement to widen the concept of through-ticketing between air and rail.

Under the new relationship, information about travel to many German rail stations from connecting Lufthansa flights appears on the CRS in a form virtually identical to connecting flight information. Figure 6-2 shows a portion of a computer screen displaying options for a trip between Boston-Logan Airport and the rail station in Cologne, Germany.

Targets for the integrated system in the joint agreement include (51):

- Full check-in from the train station of departure through to the destination airport;
- Joint ticketing between airlines and railroad operators;

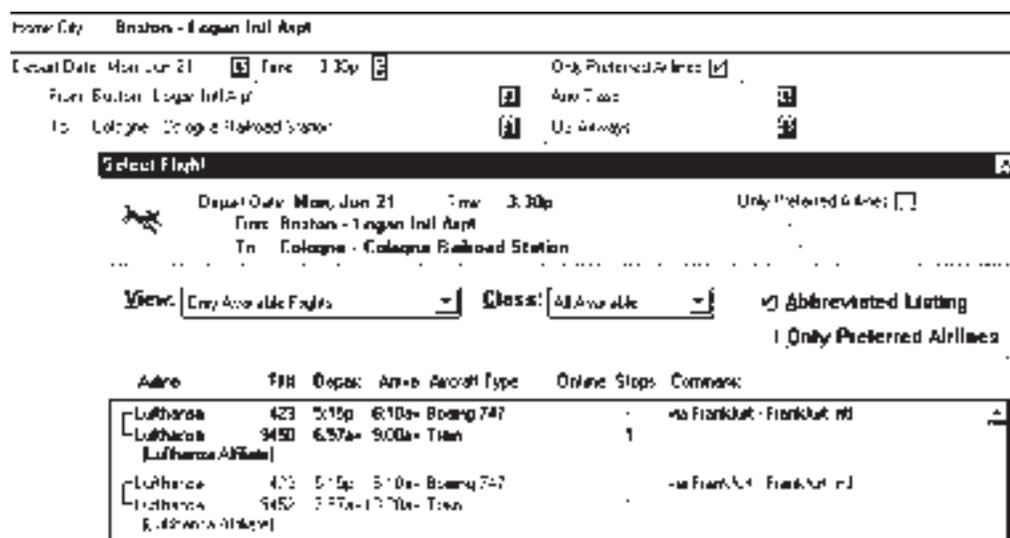


Figure 6-2. The airline reservation system can issue tickets with a ground transportation segment.

SOURCE: US Airways Priority Travel Works.

- Uninterrupted baggage transfer from the train station of departure to the destination airport;
- Computer-aided information for the passenger along the entire travel chain (fares, timetables, etc.); and
- Coordination of rail and flight schedules.

For example, from the vantage point of a traveler making a trip from Boston to Cologne, information about the ground access link is an integral part of the information offered on the computer screen, which is seen either by the traveler or by the travel agent on the traveler's behalf (see Figure 6-2). As discussed below in a broader description of the use of bus technology for airport access, United Airlines includes the full description of bus routes on its CRS. In both of these cases, the CRS process results in the selling and issuing of a ticket, which is still rare in integrated information systems.

The combined ticket-selling operation promulgated by the Lufthansa–Deutsche Bahn agreement presents an important model for future marketing of public ground transportation services. In late 1998, United Airlines announced that it would sell tickets on the Hong Kong Airport Express rail system. Currently, United Airlines sells through-tickets to passengers flying from the United States for connections on the French railway system to Lyons. Based on this success, United Airlines' alliance partner, Lufthansa, has established a code-sharing ticketing system for all Lufthansa flights between Charles de Gaulle Airport and the cities of Lyons, Nantes, and Orleans. The trains are listed in the CRS with Lufthansa flight numbers. In both the Hong Kong and Paris arrangements, a coupon is exchanged at the train station for the actual ticket.

Rules for the establishment of city codes for nonairport locations are established by IATA, based in Geneva, Switzerland. The decision to grant a three-letter airport code to non-airport destinations (such as the Cologne railway station) is made by IATA. The issuance of tickets through the IATA system is governed by standards concerning the service providers and the liability they assume for completion of a full trip. For example, if a United Airlines bus misses a United Airlines flight, the airline must provide an alternative trip to the planned destination. On the other hand, IATA does not encourage the use of its ticketing system for ground transportation operators who cannot assume certain levels of liability. Another consideration, according to IATA officials, is the finite number of three-letter codes that can be created.

The Provision of Static Information for Ground Access Routes and Schedules

While the full integration of air–ground access ticketing is being undertaken in some systems, lesser levels of information integration are also being pursued. For example, information systems operated by the airlines or airports are coordinated

with information from the local transit agency. The challenge is to provide the airline passenger with efficient and user-friendly information about ground transportation options.

Airports use a variety of strategies to provide ground transportation information to passengers. In one information strategy, the airport-operated website lists telephone numbers of local ground transportation service providers, leaving the gathering of this information to the user. At the Port Authority of New York and New Jersey's website, destinations are categorized by regional subarea, and telephone numbers for the local service providers are listed. At the same time, for services that Massport operates, actual routes, schedules, and fares are provided on the website. This pattern of offering information about the service providers, but not providing descriptions of their routes, schedules, and fares, is the strategy adopted on most airport websites.

The website for Frankfurt Airport gives actual schedule information for every train that departs or arrives at the Frankfurt airport train station, but it gives no information about any rail trip that would require a transfer. Bus lines from the airport are named, but no schedule information is included.

The Provision of Transit Itinerary Planning Information to the User

Many public mode service providers are discontinuing the dissemination of schedules describing specific routes and instead are providing *trip itineraries* describing all segments of the user's trip from origin to destination. Transit *itinerary trip planners*—software programs that guide the user from station of origin to station of destination—are in extensive use in Europe and are now being implemented throughout the United States. The basic concept behind itinerary planners has been used in airline CRSs from their inception. These airline information systems were offered to the public beginning in 1995, when access to the CRS was made public via the Internet. Amtrak first began offering station-to-station trip itinerary planning on its website in 1997.

One of the first applications of transit itinerary planning software was offered to the public by the Tri-County Metropolitan Transportation District of Oregon (Tri-Met). The software program was placed in kiosks in several downtown locations along the Fifth and Sixth Avenue transit malls. A printed transit trip itinerary from Fifth Avenue to Portland Airport is produced at the kiosk. The user inputs the desired destination and time of the trip. From this information, the program advises the user as to the appropriate bus stop and gives directions for the first trip segment, the transfer, and the second trip segment. The Tri-Met trip planning kiosks have been located to serve Amtrak and long-distance bus travelers. The kiosk is planned for operation in the Portland Airport.

A transit itinerary planning program was implemented upon the opening of Munich Airport in 1992, where the system was put in place by the regional transit operator, Munich Transport Alliance (MVV).

Off-Line Computerized Public Mode Trip Itinerary Planning

In the early 1990s, the Dutch National Railways began providing station-to-station itinerary planning software to the public for use on off-line personal computers. Every 6 months, when the schedules of the national railways change, users can purchase a 3½-in floppy disk for a nominal charge; this allows the program to be continuously updated. A trip scheduled from Amsterdam's Schiphol Airport to a suburb of Utrecht is shown in Figure 6-3. The stand-alone program presents the user with map-based graphics, which are not used on the Internet system because of the amount of processing time needed. Station-to-station itinerary planning software that does not require connections to any central database is available on CD-ROM for Germany, the Netherlands, and Sweden.

A Case Study in Passenger Information Systems: Amsterdam's Schiphol Airport

Integration with Station-to-Station Trip Planning. Higher levels of integration of information have been attempted at Amsterdam's Schiphol Airport. Here, the airport website provides the user with station-to-station itinerary trip planning, for either the domestic rail or the international rail system. The system is dynamic in that last-minute route, schedule, or fare information is immediately made available to the inquiring passenger. This system does not provide real-time data about accidents or other incidents that cause delay in the rail system. When the user of the Schiphol Airport website seeks to plan an itinerary from the airport to the final destination, the website offers connecting train information, which is provided by the national railroad information system and connected by a hyperlink. For the user of the Schiphol Airport website, a seamless connection has been made, providing full itinerary planning to the destination rail station. The user specifies the origin (in this case, Schiphol Airport), the destination, and the desired time and date of travel. The program returns with a

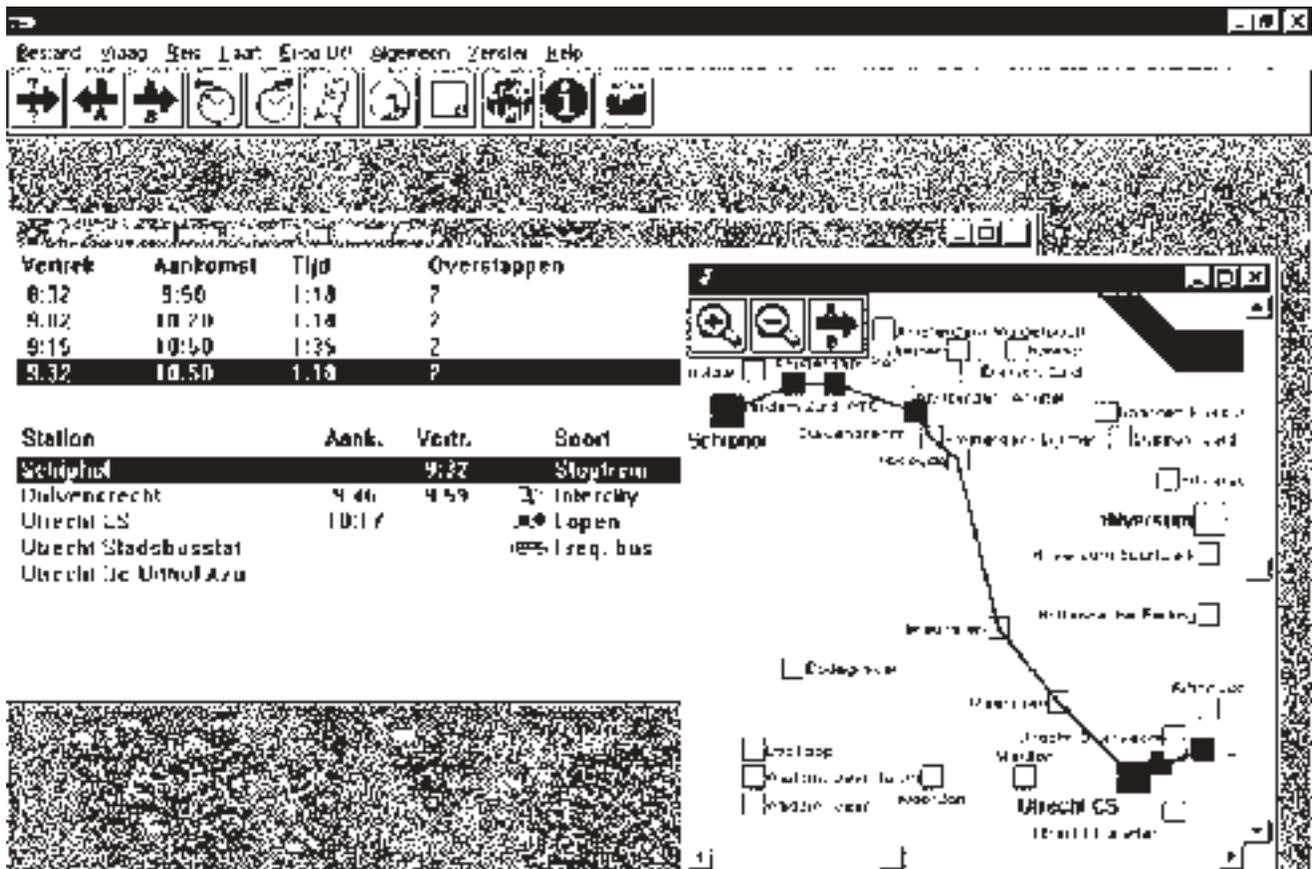


Figure 6-3. Map-based graphics are used to give the traveler station-to-station trip planning from Schiphol Airport in this off-line computer program from the Netherlands Railways.

SOURCE: Reisplanner, from Netherlands Railways.

screen showing the variety of rail connections for the requested trip at the requested hour. Integration of the systems is improving; at the website for the Geneva airport, the user needs only to specify the origin of the trip to the airport or the destination of the trip from the airport.

Multimodal Door-to-Door Trip Planning from Schiphol Airport. Recently, Schiphol Airport management has been exploring the use of a more precise itinerary planning strategy. Management is attempting to determine the best manner for the airport user to gain access to the OVR, which is the nationwide, door-to-door transit itinerary trip planning system in the Netherlands. The national rail system described above provides the traveler with a public transportation itinerary from railroad station to railroad station; the OVR system provides this information from door to door.

The OVR system in the Netherlands was the first comprehensive passenger information system in national operation. The air traveler needing specific instructions on how to use public transit modes from any airport in the Netherlands can access the OVR system, which will provide public transportation options to every street address or landmark in the nation. Figure 6-4 shows the results of a query for a trip from Schiphol Airport to the Museumplein, a square in downtown Amsterdam. The program has given the traveler a choice of four different ways to make the trip by public transportation. This screen shows that the trip could be made using a single bus, a regional bus, a train and a tram, or a train with both a tram and a bus.

The OVR system was developed to give passengers multimodal information by telephone. One common phone num-

ber throughout the Netherlands serves more than 9 million customer phone inquiries per year. The user is charged about G0.75 (US \$0.50) for the service, which is provided through a 1-900-number. The system uses nine regional call centers, at which some real-time information is presented if significant deviations occur from the travel times for most important links in the system. In 1998, the OVR system was adapted for use on the Internet; because OVR system managers have not determined a cost-effective way to charge for this service, it is currently offered for free. A program to make the service available to users at Schiphol Airport is still under development.

At the request of the Netherlands government, the OVR database is being released in a stand-alone CD-ROM format, which also includes door-to-door route planning capability for automobiles. In this concept, trip-making options by private vehicle and by public transit will be available from one combined software program. The CD-ROM system will provide unprecedented ability to analyze and compare travel options across several transit modes; however, last-minute schedule changes by the public mode operators will not be fully integrated into the stand-alone product.

Combining Itinerary Planning with Joint Ticketing in Sweden

The managers of the airport rail service in Stockholm are benefiting from the development of integrated, multimodal ticketing procedures that have been built up in Sweden over the past 20 years. The new Arlanda Express rail line, which

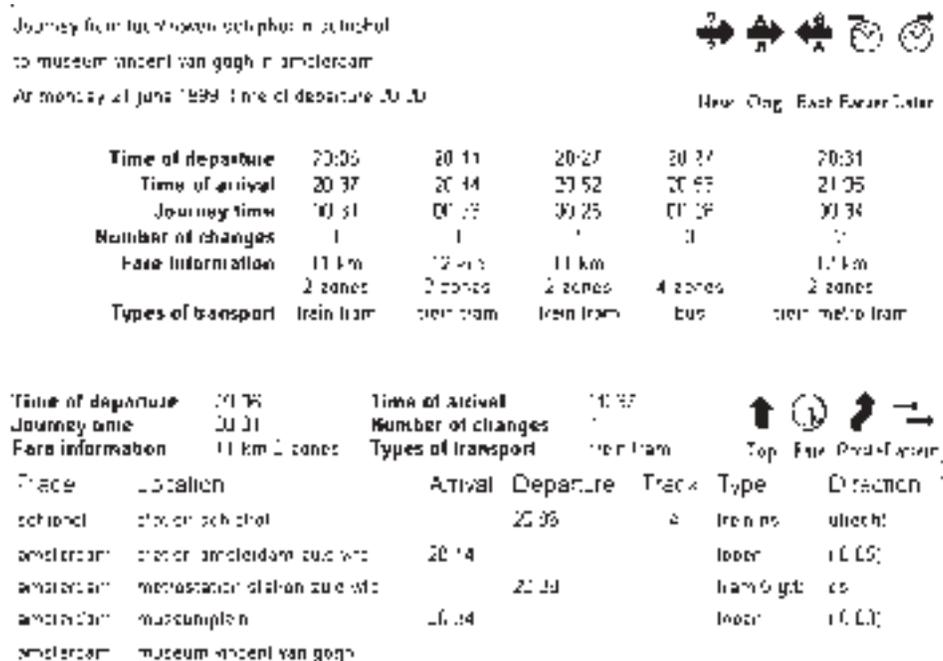


Figure 6-4. Door-to-door traveler information from Schiphol Airport is available from the multimodal Dutch OVR system.

SOURCE: Netherland Railways website (www.ovr.nl).

opened in November 1999, offers combined ground access ticketing to all destinations in Sweden. The joint ticketing program is based on the development of a state-of-the-art passenger information system in Sweden.

Swedish National Railways has established a nationwide system to give multimodal origin-to-destination itinerary planning services to a large portion of the population. Called the "Tag Plus" system, the database includes both bus and rail airport access modes (see Figure 6-5). The system covers rail and regional bus services for more than 2,000 cities and towns. The system is available to the public through multiple venues: on a CD-ROM that is updated every 6 months, on the Internet, through travel agents, and through an innovative program in which integrated public mode tickets can be purchased at local vendors who can sell and print tickets. The system shares its ticketing infrastructure with the national lottery and thus has access to thousands of terminals at tobacconists and newsstands. The lottery vendor's printer is used to print the public transportation tickets.

A traveler to the airport from anywhere in Sweden can plan the trip, either by using a CD-ROM or by logging onto the service on the Internet. The purchase of the through ticket can take place wherever a lottery machine is available. Travel agents access the Tag Plus system via the SMART system, which is a major Scandinavian reservation systems owned by SAS and Swedish National Railways.

The Arlanda Express will also offer joint ticketing with the airlines' reservations systems. Guided by SMART, the travel agent will first establish the flight into or out of Stockholm's Arlanda Airport. Then, with the touch of only one key, a joint through-ticket to downtown Stockholm is created. The system

works in cooperation with all airlines that use travel agents. When SAS ticket agents use their proprietary reservation system, the Arlanda Express options will appear on the screen and can be jointly ticketed. Users of various forms of SAS travel passes can use these cards on board the train, with SAS reimbursing the rail company for the full cost of the fares.

At the present time, the managers of the Arlanda Express are working to create a joint ticket that would include a taxi ride at the Stockholm-end of the trip. This would be based on a zone system and would provide a major step to truly intermodal seamless ticketing.

Joint Ticketing in Oslo

A ticket can be purchased on the Oslo Airport Express with connecting service to all destinations served by the Norwegian Railways. The accounting procedures are simplified because the Oslo Express is a company wholly owned by the national railways. However, the Oslo Airport Express managers have not established the same ability for through-ticketing with airlines as that which has been accomplished in Stockholm. Oslo Airport Express tickets are sold by travel agents, but the mechanics of through-ticketing with airlines are still under development.

Of the passengers now using the Oslo Airport Express train, 30 percent have received their train tickets at the time of purchase of the airline ticket from their travel agents. Only about half of the Oslo Airport Express riders buy tickets at the stations. About 20 percent of the riders use a unique credit card—the Eurobonus—developed for the service that provides direct

TagPlusGuiden - 51 och Lärstafikerna i samverkan

Avresa Fråga Visa Hjälp

Avresa	Ankomst	Hes tid	Antal byten
07:10	17:06	04:56	?
08:10	14:06	04:56	?
11:10	16:21	05:11	?
11:20	17:45	06:25	4
11:20	17:51	06:31	3

Station/Målpunkt	Tid	Förmedel	Anm
Arlanda flygplats	11:10	Länsbuss 2	
Stockholm C flygterminalen	11:45		
Stockholm C flygterminalen	10:20		
Stockholm C			
Stockholm C	12:06	× 2000 433	✗
Göteborg C	15:22		
Göteborg C	10:15	Gå	
Göteborg N Ericsonsterminalen			
Göteborg N Ericsonsterminalen	15:58	Länsbuss 4	
Göteborg Frilundatorg	16:21		

Figure 6-5. Tag Plus, the multimodal Swedish itinerary trip planner, shows a trip from Stockholm's Arlanda Airport to a suburb of Gothenburg by bus, rail, foot, and local bus.

SOURCE: TagPlusGuiden, from Swedish Railways, 1998.

billing for the train ride. The new hybrid credit card–smart card is now used for 20 percent of rail ticket sales and is currently issued by Diners Club and SAS. The standard magnetic strip establishes the credit–payment mechanisms; a microchip contains information about the actual reservation, the holder’s frequent flyer status, and so forth. One swipe of the Eurobonus card presents the airlines with all the information needed to complete an electronic ticket with multimodal content. In Stockholm, the ticket will be used on board the train, bypassing the normal time for the “handshake” transaction that is normally needed to check the credit of the customer. The information contained on the card is sufficient documentation to bypass this time consuming step. At first, the system required the prepayment of a stored value, but it now has evolved to allow later billing to the subscribing company.

Joint Ticketing: Other Examples in Airport Ground Access

In Denmark, a system of through-ticketing was developed between Danish Railways and SAS; now that system is being used for other airline carriers. Outside of Scandinavia, however, the experiences with advanced ticket sales have proved more problematic. Different rail operators are trying different marketing strategies to accomplish advance ticket sales. Market schemes have focused on the creation of one-to-one deals with specific airlines, who will market the rail ticket themselves, bypassing the need to use the wider services of the CRS or the global distribution systems (GDS), in which fees can add up to DKr 21 (US \$3) per segment of the trip. Arrangements have been established between Heathrow Express and both Virgin and British Midlands Airlines. The Star Alliance is temporarily offering free Heathrow Express tickets as a marketing scheme. In these arrangements, there is no charge from the GDS because specific reservations are not made.

An example of best case practice outside of full integration with the computer systems is the flights of Ryan Air at London Stansted Airport. On planes arriving at Stansted Airport, the flight attendants walk through the cabin selling tickets on the Stansted Express rail service to London. The flight attendants have incentive to do this, as they gain some of the commission from the ticket sales.

The EUSpirit Project

The concept of door-to-door intercity itinerary planning capability has been applied nationwide in the Netherlands, Sweden, and other European countries. Now, the European Union is proposing to provide for door-to-door intercity trip planning capability across national borders, ultimately covering the entire European Union. In December 1998, the project, named EUSpirit, was launched by a consortium of agencies under the leadership of Deutsche Bahn. In its present format, the program is designed to provide itinerary planning from any

specific address to any specific address, using the national railroads for the long-distance trip segment. The technology of integrating the long-distance routes and schedules with the appropriate local information would be equally applicable to airline schedules.

In such a scenario for airline trips, the traveler would use a computer to access the travel options between cities and the travel options at both the city of origin and the city of destination. The functionality of such a system would rival the quality of trip information now available for connections with long-distance trains in Germany and with the bus system operated by United Airlines. Joint ticketing over the many service operators remains a longer-term goal, awaiting implementation of automated fare payment technology.

Dynamic Itinerary Planning Services in the United States

Itinerary planning programs for public transit are being developed under several separate technical and institutional models. Many transit agencies are adapting the software used for telephone operator–based information services for keyboard interaction in kiosks and through the Internet. Others are building new, regional software programs. Transit itinerary planning on the Internet began in 1999 by WMATA, based on its well-developed program of providing trip information by telephone operator (see Figure 6-6). In the New York Metropolitan Area, new programs are being established based on software previously unused in that region.

Southern California Association of Governments. The system with the highest multiagency coverage was first developed by the Southern California Association of Governments (SCAG). Based on its experience in matching rides for carpools, SCAG developed the TranStar program (see Figure 6-7). Similar to most passenger information systems, the program was originally developed to be used by trained telephone operators. However, the program has been available for several years to Internet users through the Ventura County, California, ATIS program.

The SCAG TranStar technology was adopted in northern California, as part of a wide-reaching program by the Metropolitan Transportation Commission in the development of its multimodal TravInfo™ program. Users call a common telephone number (common over several area codes) to access local operators using the TranStar database. Translation of this operator-oriented system into a user-operated system (whether through the kiosk keyboard or via the Internet) is now under way in several metropolitan areas.

The New York–Area Model Deployment Initiative Project. The United States Department of Transportation (U.S. DOT) encouraged the further development of multimodal itinerary planning capability in its Model Deployment Initiative

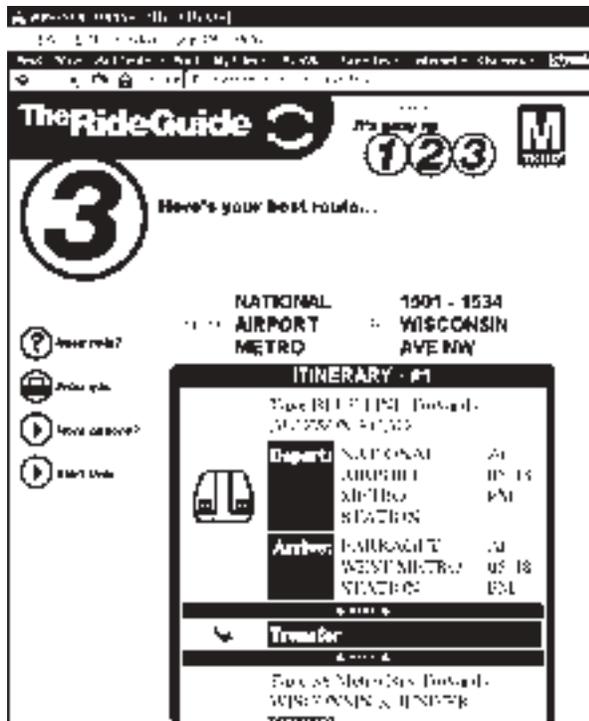


Figure 6-6. In 1999, door-to-door transit itinerary trip planning was introduced in Washington, D.C., by WMATA.

SOURCE: Washington Metropolitan Area Transit Authority website (www.wmata.com).

(MDI). Of the cities selected for the program, New York City and the surrounding area proposed the most far-reaching attempt to bring multimodal itinerary planning to the consumer. After considerable effort to start the contract, Transcom—the independent management organization managing the MDI project for the participating agencies—selected the SCAG TranStar program as the base of its ambitious program of developing multimodal, multiagency, and multijurisdiction trip information. The comprehensive program to provide door-to-door transit itinerary planning throughout the New York Metropolitan Area (including parts of New Jersey and Connecticut) would, when applied to the New York–area airports, significantly improve the quality of transit directions available to the intercity user planning a trip from the arrival airport to the user’s actual destination.

Lessons Learned: Provision of Transit Information to the Passenger

The challenge for any system on which travelers rely is the accuracy of the route and schedule information used, through whatever technology, in the development of itineraries. A bus schedule input into the computer for the winter timetable may be totally inaccurate for the spring timetable. Therefore, it would appear necessary for airport operators to rely on systems that tie into a larger database, managed and updated by

other information providers. For all systems, however, the dissemination of inaccurate or out-of-date information is possible. The challenge is for the airport to offer the public transit user access to a database that is certified by some agency with a wider client base than those airport users choosing public transit modes.

Information at the Time of Trip Commencement

State of the Art

The previous section described developments by the public transportation industry, including national railroads, to provide the transit user with accurate descriptions of routes, schedules, and fares for use when planning a trip. The information is either *static* (not continuously updated) or *dynamic* (continuously updated, but not in real time). At the time of departure for the beginning of a multimodal trip, accurate, *real-time* information about actual conditions is necessary. Accurate information about the travel-time characteristics of the regional transit system is difficult to assemble and is probably beyond the institutional responsibility of either the transit agency or the airport operator to manage. In many U.S. cities, real-time information about the status of the regional transportation system is being made available to the traveler.

Information at the time of trip commencement is supplied by radio, automated telephone, and the Internet. Several U.S. cities have begun programs to provide customized information to the transit user. In Seattle, Microsoft test-marketed a program to send e-mail messages describing traffic conditions about a given location at a fixed time everyday. In 1999, Microsoft dropped the Trafficview program in Seattle and other cities. Now, Seattle travelers can sign up for a warning service for weather-related changes in routes or schedules for the bus and ferry systems (52).

ATIS designed to provide congestion-related information to the traveler are in operation throughout the United States. Some of these systems, such as the SmarTraveler® system, allow the user to ask the status of congestion at the major airport or on the key regional roadway links. Information about the level of congestion and travel-time delay on that roadway link is provided to the customer via automated phone line or the Internet. For transit services, however, the program operates on a different principle: only under the most unusual circumstances are delays in the transit system reported.

A good example of the use of real-time information to aid transit riders destined for the airport is the Busview program included in the comprehensive Seattle MDI, which is entitled “Smart Trek.” The Busview program, developed at the University of Washington, allows the user to track the location of all buses in the region, or, more logically, a specified bus route of interest to the user. Figure 6-8 shows a scenario for a user wishing to board a bus to Seattle-Tacoma Airport at the bus stop at South Spokane Street. The user specified that an alarm should sound on his or her computer when the bus passed a given point on the line, in this case a point located

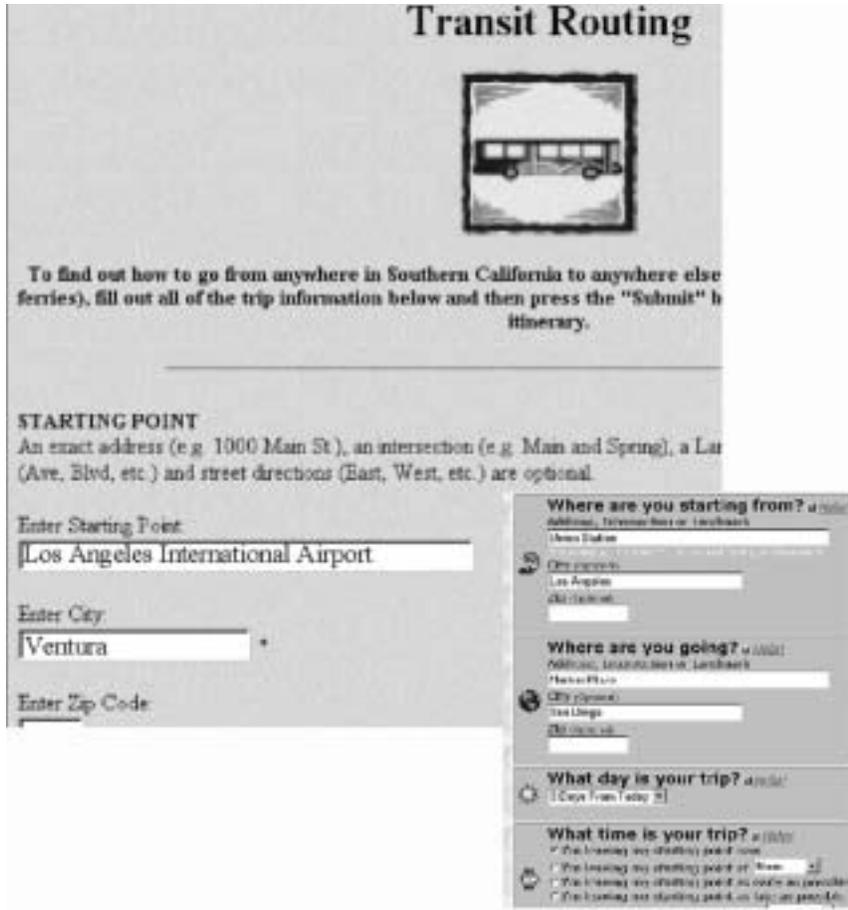


Figure 6-7. Door-to-door passenger trip itinerary planning from Los Angeles International Airport is provided using the TranStar software program.
 SOURCE: Ventura County Transportation Commission website (www.goventura.org).

1.35 mi from the bus stop. When the bus passes this point, a warning is sent to the user to proceed to the bus stop. The program is also map based, allowing the user to visually establish the location of each bus on a map.

Real-Time Information for the Intercity Traveler

Currently, very few sources of information are designed for the intercity traveler. There is currently no national program to provide comprehensive local ground access public mode travel information to the intercity traveler. The Business Plan of the I-95 Corridor Coalition calls for origin–destination itinerary planning for intercity trips throughout the 12 states of the Northeast Corridor. Organizations such as the Airport Ground Transportation Association are currently working with website developers to increase the visibility of their member operators. Other programs under development to link the traveler with

selected ground transportation options include Ridesource.com and QuickAid, which will be discussed below.

Implications for Public Transit Modes

In theory, traffic congestion around U.S. airports could serve as an incentive for the traveler to choose public transport modes with separate right-of-way, including rail, ferry, and HOV-lane systems. The extent to which the traveler actually alters his or her transit mode at the time of trip commencement is unclear from the available data. For recurring congestion, the expected travel times are known in advance. For nonrecurring congestion (e.g., from accidents), programs to monitor roadway conditions could be used to warn airport-bound travelers to allocate more time or, when possible, to switch to a public transit mode. At the present time, however, these programs are not specifically aimed at the needs of the traveler seeking a ground access connection.

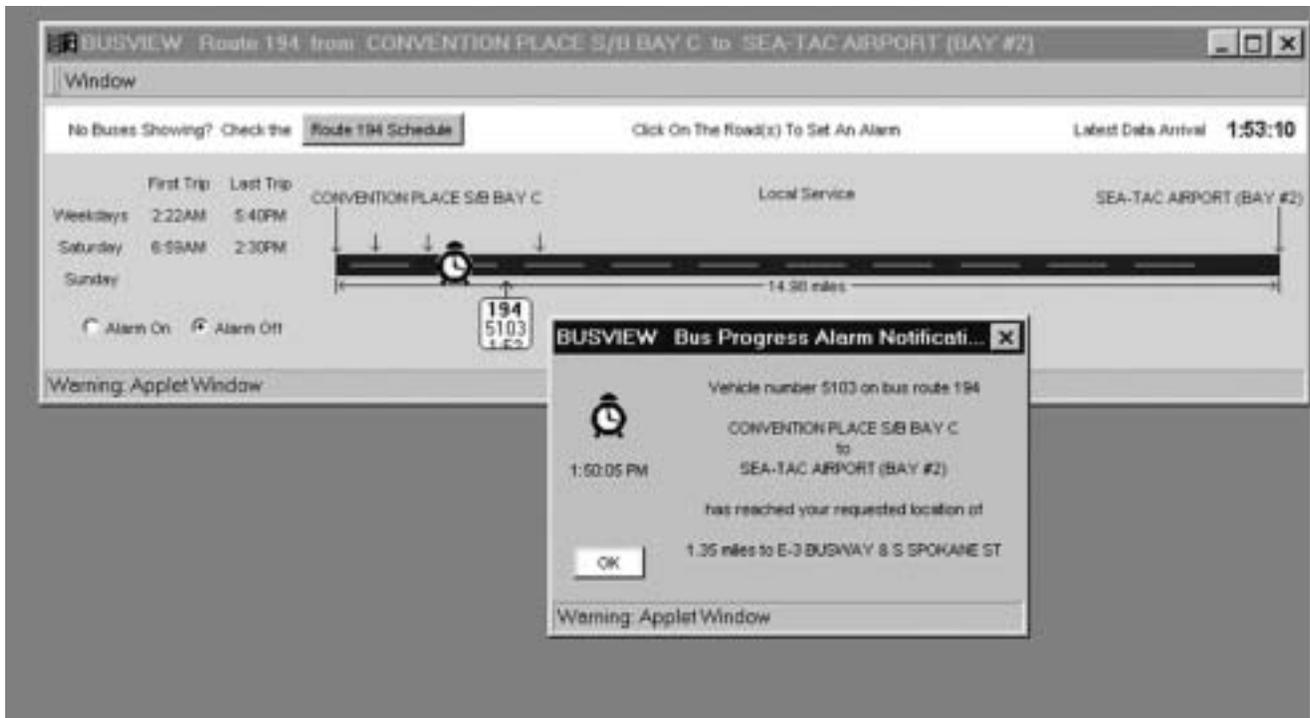


Figure 6-8. The user's computer sounds an alarm when Metro's Route 194 bus to Seattle-Tacoma International Airport is 5 min from the user's bus stop in this program from Seattle's Smart Trek.

SOURCE: Smart Trek website (www.smarttrek.org).

Information While En Route

The intercity traveler experiences a succession of trip segments to get from origin to destination. While on each segment of the trip, the traveler is in need of information about the next segment. Obtaining information en route is especially important for the user of public airport access services.

Many programs have been designed to improve the quality of information at the traveler's point of transfer. Reliable, real-time information has to be accurate to the minute and include exact information about the status and location of the connecting mode. Although accurate information about departure gate and flight status is a basic assumption within airports, information to aid the transit user has been slower to develop. With worldwide interest in intelligent transportation systems (ITS), efforts are increasing to provide en-route information to the public transit user.

Provision of Scheduled Departure Information to the Transit Rider

For several decades, transit operators have been working to provide information about the scheduled arrival and departure times of their services. An early example of this commitment is the development of the passenger information system at

major bus stops in Portland, Oregon. Carefully designed, vandal-proof television monitors were placed in each shelter in major areas, such as the Fifth Avenue transit mall. The waiting passenger is told the current time and is given a list of buses that are *scheduled* to depart during the next half hour. Officials at Tri-Met are working on the implementation of real-time information for the shelters.

At London's Heathrow Airport, which serves as one of the largest bus stations in the United Kingdom, a computerized information system has been installed. Television monitors are in operation at 22 bus departure platforms. The program lists departure times for all national and local bus destinations. At the present time, Heathrow Airport is adding the ability to provide real-time information about bus operating conditions for the public.

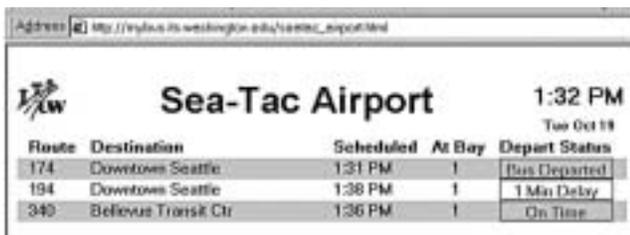
Currently, the provision of such basic public transit information is rare at U.S. airports. Until recently, a television monitor provides scheduled bus departure times at Bush Intercontinental Airport/Houston. In most cases, the arriving passenger is referred to an information booth, which then distributes a schedule for a specific company, but not a combined timetable of any form. Many airports list the telephone numbers of private companies: the user first must determine which company is most appropriate for the planned ground access trip and then must call for a pickup time and location.

Provision of Real-time Information to the Traveler En Route

In general, most U.S. airports have not provided even static ground transportation information of a quality provided by transit agencies such as Portland's Tri-Met, which has offered waiting passengers both schedule information and station-to-station trip planning information for more than a decade. With the increased interest in ITS technology, this is changing in some airports. Programs to create high-quality, real-time information about local transportation have begun at the Seattle-Tacoma Airport and in transit systems around the world.

Seattle MDI Program. In Seattle, Washington, MDI has developed the MyBus system to provide computer-based displays of the real-time schedules of buses serving Seattle-Tacoma Airport and selected transit transfer centers (see Figure 6-9). The computer-based monitors that are being implemented at the Seattle airport provide real-time information to air travelers waiting for Seattle Metro buses going to downtown Seattle. At present, transit managers have no plans to provide information about privately owned buses serving the downtown from the same departure location. The transit buses will be equipped with global positioning system (GPS) devices, which will allow management to know the buses' location anywhere on the system; operators of the private buses do not use such location devices. Access to a computer screen with real-time highway congestion information is also available at the Seattle-Tacoma Airport.

Gothenburg, Sweden's GoTic. The first city to monitor its entire transit operations, including buses, for real-time travel conditions was Gothenburg, Sweden, through a city operation called "GoTic." The monitoring program originally was undertaken to deal with traffic flow and signal preemption; program information was made available to waiting passengers in the 1980s. Passengers at key transfer points are given the exact time of the next four departures from that platform; passengers on board the buses and trams are informed



Address: http://mybus.its.washington.edu/seatac_airport.html

Sea-Tac Airport 1:32 PM
Tue Oct 19

Route	Destination	Scheduled	At Bay	Depart Status
174	Downtown Seattle	1:31 PM	1	Bus Departed
194	Downtown Seattle	1:38 PM	1	1 Min Delay
340	Bellevue Transit Ctr	1:36 PM	1	On Time

Figure 6-9. The Seattle MDI's "MyBus" Program supplies real-time information about local bus departures to monitors at Seattle-Tacoma International Airport and to the Internet.

SOURCE: MyBus website (www.its.washington.edu/mybus).

of the types of any delays from a centralized control center. Figure 6-10 shows a typical departure sign at a tram shelter.

London's Countdown Project. Although Gothenburg was the first city to provide vehicle location information over its entire fleet, the largest implementation of the concept is London Transport's Countdown project. The Countdown project was based on a program that was initially undertaken to announce the actual time before the next train departure; London Transport tested the concept of giving passengers the actual time before the next bus and is now implementing the project throughout its system. London Transport extensively studied the market reaction to the project and found that the users believed that waiting times had decreased, even though actual times had not changed.

Kiosks

Significant research has been undertaken on the effectiveness of kiosks in providing transit information, particularly at points of transfer such as airports. The use of kiosks as a means of providing transit information has been tested throughout the country, with one of the largest tests undertaken by the Los Angeles County Metropolitan Transportation Authority. More than 75 kiosks were sited in a variety of test locations, including office buildings, retail centers, and transit stations. Findings of the research evaluation program suggested that the strongest market was for trips other than the daily trip to work (53).

QuickAid. The Quick ATM Corporation has developed a program that provides ground transportation information, in various degrees of detail, for 31 U.S. airports. Development



Figure 6-10. This passenger information sign in Gothenburg, Sweden, was part of the first system to provide real-time information for bus passengers.

Photo: Matthew A. Coogan

of the QuickAID program was encouraged in 1993, when the Division of Aeronautics of the California Department of Transportation (Caltrans) undertook a demonstration program to showcase the potential of passenger information systems. Kiosks were built in airports in Oakland, San Jose, Sacramento, and Burbank. Outside of the Caltrans demonstration, 50 additional kiosks were installed at Los Angeles Airport. As part of the Caltrans program, an evaluation of the project was undertaken by the Institute of Transportation Studies at the University of California at Berkeley (54). Surveys revealed that about 30 percent of the passengers arriving at the airports studied had a need for information, with about 15 percent seeking information about ground transportation options. Need for information varied among terminals, with the passengers on the shorter-distance Southwest Airlines flights having the least need for information.

The QuickAid system is an example of a “text-based” ATIS. Every question from the user sets in motion a narrowing process that leads to a prepared text describing directions to the destination. The system “looks up” the appropriate prepared text and does not compute any new information in the process.

Implications for Airport Ground Access Programs. Kiosks also provide the user with an alternative to the staffed information booth. Whether information is disseminated through a booth or through a kiosk, the key element is the existence of accurate, up-to-date, systemwide information based on current schedules and timetables. In many cases, achieving this accuracy will require the development of specific methods of accessing regional information maintained and developed by other information providers. The database that will be prepared for the New York MDI project, for example, could be used by trained staff and at kiosks. The kiosk, although linked to the MDI database, could be designed to respond to the specific needs of the airport passenger. Airport operators may find it beneficial to link up with larger-scale, metropolitan efforts to implement ATIS, while still focusing on the specific needs of the air traveler.

En-Route Information: The Promise of Automated Vehicle Identification

Automated vehicle identification (AVI) systems are used at airports (1) to control the operations of taxicabs, buses, and other commercial vehicles; (2) to control vehicular access to restricted areas; (3) to assist in the dispatching and control of airport-operated shuttle buses; and (4) to provide a basis for charging activity-based user fees. From the point of view of airport management, AVI systems offer the ability to track the behavior of each licensed airport vehicle to ensure that airport regulations are being followed. Now, several U.S. airports are considering the use of vehicle location systems (such as AVI) to provide accurate real-time information about the actual de-

parture times of connecting ground transportation. This information could be provided in interior waiting areas to users of the connecting bus services.

Implications for Airport Ground Access: En-Route Traveler Information Technology

The traveler who has arrived at the airport and must choose, locate, and pay for a public ground transportation service is a strong candidate for assistance from the en-route category of U.S. DOT’s ATIS program. Travelers need to learn quickly what public transportation service options they have, when the services are departing, and from where the services are departing. Programs already in place in transit systems around the world, such as London Transport’s Countdown program and Seattle’s Smart Trek program, could help provide that public transportation information to connecting ground transportation passengers at U.S. airports.

TECHNOLOGY FOR RIDE MATCHING

A key goal for airport managers and regional transportation planners is to increase overall vehicle occupancy to and from the airport. Airport managers and transit agencies around the world have followed many strategies to “match” trips, increase the number of parties in a single vehicle, and improve efficiency.

Examples of Strategies To Match Trips

Currently, FTA’s Advanced Public Transit Systems program includes research about automated scheduling (in which the path of the bus is established) and automated dispatching (in which the orders are sent to the bus). Research programs on the use of flexibly routed and dispatched buses are being undertaken in Richmond Hill, Ontario, and in the Westlake MacArthur Park region of Los Angeles. Transit industry improvements in the efficient scheduling and dispatching of shared-ride services could be used to improve an airport’s ability to provide efficient shared-ride services (55).

Transit planners are examining the concept of route deviation, in which the bus has a fixed origin and fixed destination point. Along the line, some stops would always be served, and the operator could deviate from that route for requested extra stops. In Prince William County, Virginia, a route deviation bus has been operating since April 1995. Originally, requests for special service had to be received between 24 and 48 hr in advance. Improvements in the scheduling and dispatching process have decreased that timing to 2-hr advance notice. Similar experimental services are in operation in York, Pennsylvania, and South-central Los Angeles (56).

Good examples of efforts to increase taxi occupancy rates exist in Linz, Austria, and throughout the Netherlands. In Linz,

transit operators found that the operation of late-night buses was highly inefficient, but that demand did exist for service. The transit agency provides taxis to serve the bus route every 30 min from 8 P.M. to midnight, and every hour from midnight to 4 A.M. Passengers pay 150 percent of the bus fare and must request the service at least 30 min ahead of the desired pickup time. The transit agency estimates that it saves significant amounts of subsidy per year from operation of the program. Similar shared-taxi operations to replace fixed-route and scheduled services exist in France (at La Rochelle and Saint-Bieuc) and in Germany (Tübingen) (57).

One of the strongest precedents for use of matched trips at U.S. airports is the Treintaxi program organized by Dutch National Railways. The program was originally designed to increase intercity rail ridership by providing lower-cost taxi service to and from the main train stations. The service is offered in 81 cities, but not in Amsterdam or the Hague. From the train station, the rider is asked to wait about 15 min to enable the dispatcher to find a matching ride; then, the taxi is dispatched with or without the matching ride. From a residence, the trip must be requested at least 30 min in advance. The program accommodates 3.6 million riders per year with an average vehicle occupancy of 2 riders per trip. At present, customers are not required to show a rail ticket to use the taxi service. Figure 6-11 shows the operation at Utrecht Central Station.

The SAMPO Project: Advanced Application of Automated Dispatching

In the European Union, tests were performed as part of a wide-ranging program called the System for Advanced Public Transport Operations (SAMPO). The SAMPO program included a series of demonstrations of methods developed to match riders in order to achieve higher overall occupancy rates for buses in Italy, Finland, Belgium, and Sweden. Each of these projects was intended to improve the efficiency of pro-

viding specialized transit services to areas with low-density trip endings—a pattern common to that of U.S. airports. Within the SAMPO program, the Flexline project in Sweden is particularly relevant to U.S. airports.

The Flexline Project

The Flexline project in Gothenburg, Sweden, is a successful example of a way to increase the ground transportation system throughput. The system is a route-deviation model in that the bus always leaves from the same point and arrives at the same point but takes a different route depending on the rides that are matched. This operating format parallels that undertaken by many airport van operators, who dispatch trips to a given corridor on a regular basis.

The project is important to this research in the transit industry in that the new software program—PLANET—combines both automated ride-matching software and automated dispatching techniques. In one aspect of the project, the traveler uses an identification card with home address and relevant booking information. At the town center, the traveler swipes the card into a telephone-based connection that transmits the user's destination to the central computer (see Figure 6-12). The automated software then determines which bus trip the user should be assigned to and sends a dispatching order directly to the driver on the bus (see Figure 6-13). All of this occurs without the intervention of a telephone operator or staff. The project has resulted in an overall vehicle-occupancy ratio of six passengers per vehicle, which is much higher than the occupancy ratios for the series of specialized services that were replaced by the new system (58).

Implications for Airport Access

The SAMPO automated dispatching project has many implications for improving overall vehicle-occupancy levels at



Photo: Matthew A. Coogan

Figure 6-11. Shared-ride taxi systems have been successfully implemented in the Dutch National Railways' Treintaxi program.



Photo: Matthew A. Coogan

Figure 6-12. This card reader triggers a program that automatically schedules and dispatches a shared-ride bus in Gothenburg, Sweden.



Figure 6-13. Revised routes and passenger requirements are dispatched automatically to the driver of the shared-ride bus in Gothenburg, Sweden.

airports. SAMPO represents an important initial application of the concept of automated shared-ride scheduling and trip dispatching. This concept could be applied at several levels of complexity and different price points within the airport ground access system. The same technology could be used to place 2 parties in one taxi or 10 parties in a medium-sized bus. The key element is that the task of matching and dispatching is centralized and operated by the public sector and is not left to private operators.

EMERGING BUS TECHNOLOGY

As was discussed in Chapter 2, the primary public transit mode to U.S. airports is some type of bus. With rare exception, the bus service departs from some exterior waiting area where passengers are expected to wait in the cold, heat, rain, or snow. Although these conditions are common for bus passengers around the world, FTA has taken the lead in examining alternative strategies to address these and other concerns, such as accessibility for the disabled traveler. Extensive research has been undertaken around the world, including the development by German engineers of the “guided bus” shown in Figure 6-14. The results of this examination of urban transportation services could have major application at U.S. airports. This section summarizes areas of recent research in the development of higher-performance bus systems. Examples of advanced bus system designs are then provided, as well as a discussion of airline operation of bus systems.

Bus Rapid Transit

FTA has undertaken a national program to improve the performance and productivity of bus systems, and several elements of that program have direct and immediate application to airport ground access services. The total program includes



Figure 6-14. German guided-bus technology has been examined for use in airport access.

SOURCE: Daimler Benz.

concepts such as bus lanes, bus streets, busways, signal preference, traffic management, fare prepayment and all-door boarding, high-quality amenities, and integration with land-use policy. Each of these concepts is applicable to the task of improving the quality of public transit services to airports. In addition to experience in the United States and Canada, the FTA program highlights the highly innovative bus system in Curitiba, Brazil. The basis of this Brazilian system is known as “bus rapid transit,” characterized by the use of “high-level” platforms for getting on and off the bus and resulting in a typical bus station dwell time of only 15 to 19 sec (59).

The Level-Entry Bus Concept

The airport passenger nearly always carries baggage, whether on board the plane or for through-checking. The need to accommodate such baggage creates a challenge in designing a successful public transit system. The potential to design a vehicle that can be entered and exited without steps has implications for every passenger carrying baggage, as well as for compliance with ADA. The concept of level entry is a key element in the bus rapid transit strategy. This concept has been examined and developed over the past 2 decades, in both the United States and Europe, for operation in transit systems and for airport access.

Level-entry boarding is a characteristic of many rail systems. In the United States, transit vehicles that operate only on private rights-of-way, such as the light rail service to Lambert-St. Louis Airport, are typically designed to provide level-entry boarding; those transit vehicles that operate on public streets, such as the light rail service to Baltimore-Washington Airport, typically require passengers to climb steps to board the vehicle. San Francisco Municipal Railway light rail vehicles are designed with a convertible system, which uses on-board steps for street operations and level-boarding in the tunnel under Market Street in downtown San Francisco. Over

the past decades, significant research and product development have been conducted to enable buses to have level-entry boarding similar to rail systems. Conceptual research was undertaken at Boston-Logan Airport on a system of level-entry buses to be used for on-airport circulation as well as the off-airport access system.

In the late 1980s, the Curitiba bus was brought to Lower Manhattan for a demonstration. The Manhattan demonstration used a prepayment system, in which riders enter the station at a sidewalk-level turnstile and then take a ramp up to the bus floor-level platform. Prepayment allows the use of both the front and back doors of the bus. (An honor-system pass made the back door usable by the majority of bus riders in the Halmstad experiment, which will be discussed below.) Following the example of the Halmstad bus, the Brazilian Curitiba bus used a bridge-extension concept. Figure 6-15 shows how the bridge appears from within the bus.

This brief review of the development of the level-entry bus suggests that the technology exists to enable airport users,



Figure 6-15. The Halmstad technology was refined with the use of a simple bridge in the Curitiba bus system in Brazil.
SOURCE: Oliver Gilham.

many of whom have bags or strollers, to gain access to the floor level of a bus without using steps. The ADA compliance implications of the level-entry bus are another major reason for exploring the potential of this technology.

Options for Bus Rapid Transit: The Guided Bus

For about 20 years, the transit industry has been examining the type of guidance needed to ensure safe level-entry boarding of buses. Two-sided, one-sided, and electronic guidance technologies have been developed.

Two-Sided Guidance. Initially, research focused on a concept developed in Germany, in which the bus operates on a guideway that provides lateral guidance on both sides of the vehicle. The earliest proposal for a bus with two-sided guidance in the United States was for the Seattle, Washington, bus tunnel. In the 1980s, studies were undertaken by a German research consortium for the Seattle Metro. These studies proposed a bus with dual-platform capabilities. All doors on the right side of the bus would be designed for low-level boarding, with steps leading to the curb. All doors on the left side of the bus would be at the floor level of the bus. In the downtown tunnel, center-platform stations would be served by the high-platform doors on the left side of the bus.

Buses with two-sided guidance use a guider wheel on the right and left sides of the bus, operating in a trough between the two guidance walls (see Figure 6-16). Demonstrations of two-sided guidance buses were undertaken in Essen, Germany. The two-sided guidance concept was developed by Daimler Benz as the O-Bahn System and was implemented in Adelaide, Australia. The O-Bahn System is now under consideration in Eugene, Oregon.

Ultimately, Seattle chose a low-platform system for the downtown bus tunnel and did not pursue the high-platform



Figure 6-16. Two-sided guidance allowed precise docking at platforms, a key goal of the bus rapid transit concept.

concept any further. Seattle did implement the first U.S. system to use dual-propulsion vehicles, which allowed electrified service in the tunnel portion of the trip and diesel-powered service on the streets and highways. Currently, the Seattle Metro operates articulated, dual-propulsion buses from the downtown bus tunnel directly to the Seattle-Tacoma Airport (see Figure 6-17).

One-Sided Guidance. A second form of guidance strategy, developed in Germany, relies on guidance from one side of the bus rather than from two. Both systems use a rolling horizontal guider wheel connected to the steering system of the front axle of the bus. The concept of one-sided guidance is based on the driver (or automated feature) biasing the wheel to one side, where contact is made with the guider rail. With this technology, a highly accurate approach can be made to the high platform, resulting in a minimized gap between the platform and the bus floor. Early prototypes of this bus were built and operated in Utrecht, the Netherlands. The development of what is now known as the Curitiba bus evolved out of Swedish efforts to design an electronic guidance system to approach the platform area.

Electronic Guidance. The Swedish government undertook a major demonstration of the concept of the level-entry bus in Halmstad, in central Sweden. In this demonstration, the Volvo Corporation developed a new prototype for an urban city bus with a lower floor than was previously available. Throughout the city, 24-in platforms were developed, often with landscaping. Each door was equipped with a bridging device that extended out from the bus to make contact with the raised platform at the curb (see Figure 6-18). Each right-hand door was equipped with a detection device to “read” whether the stop was to be made at a high or low platform. Initially, the Volvo Corporation linked the project with an automated steering sys-



Figure 6-17. The Seattle Metro operates a dual-propulsion, articulated bus from Seattle’s downtown tunnel to the Seattle airport.



Photo: Matthew A. Coogan

Figure 6-18. Level-entry capability was accomplished in Halmstad, Sweden, without use of guidance technology.

tem, designed to bring the bus to the optimal location at the station. However, drivers resisted giving control of the vehicle to the automated system, and this aspect of the research project was dropped.

From the Halmstad demonstrations, it became clear that the bus could approach the right curb within a tolerance of a few inches, with some form of bridge making the final connection to the raised platform. With the cooperation of the Volvo Corporation, the concept was then developed on an island near Oslo, Norway, the location of a large population of wheelchair-bound transit users. After Halmstad, the Norwegian application had the highest in-service use of high-platform buses until Curitiba, Brazil.

Examples of Advanced Bus System Design

Massport’s Experience with Developing Bus Technology

Level-Entry Buses at Boston-Logan International Airport. In the 1980s, the use of low-floor technology for bus and light rail transit increased rapidly. The Cross Harbor and Regional Transportation Study, undertaken by Massport in cooperation with Boston’s Central Artery/Tunnel Project, concluded that two-sided bus guidance was not appropriate for the airport context. Massport focused on solutions that brought the bus to the platform, with or without a guidance wheel. Plans were explored for the use of a level-entry bus at the point of transfer between the rapid transit airport station and Massport’s shuttle bus (see Figure 6-19). The assumed bus technology was the same as that ultimately chosen for Curitiba. The Massport team examined the concept of the high-platform bus providing service to terminals with doors connecting the bus to interior heated or air-conditioned waiting areas. Much as the people mover provides service from interior space to interior space, the bus rapid transit concept

Photo: Matthew A. Coogan

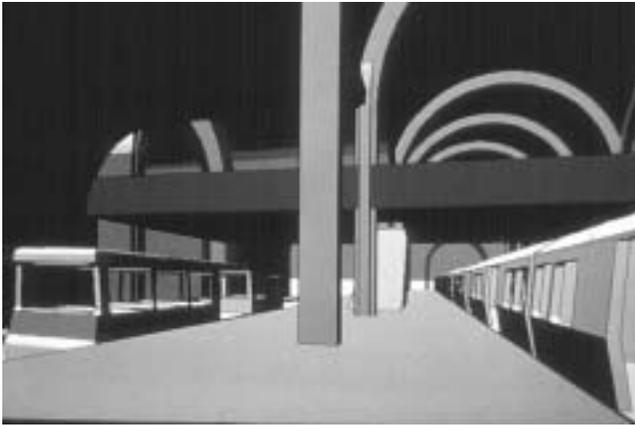


Figure 6-19. The high-platform level-entry bus was proposed for this cross platform connection at Boston-Logan Airport.

SOURCE: Computer-aided drawing prepared by the Central Artery/Third Harbor Crossing Project, Boston, Massachusetts, 1989.

would allow travelers to make their trip without experiencing outdoor weather conditions.

At present, the proposal for a cross platform–level connection with the rapid transit system has been abandoned. Work on an advanced bus system continues in Boston, with a dual-propulsion bus tunnel planned to connect with Boston-Logan.

Reversible Lane Technology: The Zipper Lane Project.

Boston's Central Artery/Tunnel Project incorporates the nation's first roadway to be used exclusively for bus and commercial vehicle operations; the roadway connects the Ted Williams Tunnel and the Southeast Expressway. The project also included a reversible bus lane on the Southeast Expressway to Braintree, using a movable concrete barrier known locally as "the Zipper." Because the Ted Williams Tunnel is temporarily operating for bus and commercial-vehicle traffic only, the Massport Logan Express bus can operate from Boston-Logan Airport to Braintree with exclusive, managed lanes for almost all of the trip. The Braintree service increased from an average daily ridership of 835 to 1,290 shortly after the inauguration of the new radial bus lane and the commercial-vehicles-only Ted Williams Tunnel. This increase in ridership resulted from the coordinated HOV policy, the use of zipper-lane technology, and various other factors.

Pittsburgh's Airport Corridor Busway

A state-of-the-art example of how airport access planning can be integrated into a larger strategy for access and mobility in the region is being developed in Pittsburgh. In 1990, the Port Authority of Allegheny County, in association with the Pennsylvania DOT, completed the Parkway West Multi-Modal Corridor Study and the Airport Busway Transitional Analysis. The transitional analysis included a comparison of light rail,

busway, and other HOV strategies. Light rail transit was eliminated from consideration because, compared with a busway, it was found (1) to cost two to three times more to construct, (2) to cost significantly more to operate and maintain, (3) to operate at essentially the same speed, and (4) to attract no more passengers. The report noted that light rail transit could not be staged incrementally, and the busway could (60).

The Southwest Pennsylvania Regional Planning Commission forecast that the current travel time of 46 min from downtown Pittsburgh to the airport would increase to 90 min by 2010. The travel-time savings forecast to result from the busway project are substantial. For example, the travel time from the airport to downtown in 2005 is expected to decrease from 55 min to 29 min. The Final Environmental Impact Statement (FEIS) for the project estimated that service quality would improve and significant numbers of additional riders would be attracted, resulting in a reasonable cost per additional rider.

The Phase One Airport Busway/Wabash Project is an 8.1-mi, two-lane roadway from Parkway West to downtown Pittsburgh. Of that distance, 7 mi would be used exclusively by buses, 0.7 mi would be shared with HOVs, and the last 0.4 mi would use a new HOV bridge over the Monongahela River. Between the Parkway West highway entrance and Station Square, there would be seven stations, which could be bypassed by an express bus service. As stated in the FEIS, the project is expected to cost \$307.8 million, with buses costing an additional \$9.6 million.

The busway project essentially provides the option of avoiding a highly congested section of I-279. How often the airport bus would use this routing is not yet clear, as the busway alignment is somewhat longer than the general-purpose highway that it bypasses. The airport buses will use general-purpose lanes between the airport and the intersection of Parkway West and the busway to the borough of Carnegie. Although the corridor is labeled "Airport Busway," the actual number of airport travelers expected to use the service is not set forth in the FEIS. To encourage commuter riders to travel into downtown, a 600-car park-and-ride facility will be in operation at the abandoned airport terminal.

Only a relatively small number of airport ground access systems use bus-priority treatments, such as exclusive busways and HOV lanes. The Seattle Metro operates an airport bus over the HOV lanes of I-5. Morning peak-hour buses from Newark International Airport benefit from the bus lane, which leads to the entrance of the Lincoln Tunnel. During some hours of the day airport buses from LaGuardia Airport make use of a peak-hour lane that gives priority into the Midtown Tunnel to Manhattan. A good example of the use of bus priority treatment is the use of a shared bus and light rail right-of-way through the center of Gothenburg, Sweden (see Figure 6-20). These buses avoid general-purpose traffic, while distributing passengers directly to the major CBD destinations.



Figure 6-20. This airport bus uses exclusive bus/tram lanes throughout downtown Gothenburg, Sweden.

Airline Operation of Bus Service

In a model related to the through-ticketing between airlines and railways in Europe, several airlines operate bus connections that use a through-ticketing system. From Frankfurt, Lufthansa German Airlines runs buses to Heidelberg, Mannheim, and Talheim, Germany. Japan Airlines runs a bus service from Frankfurt Airport to Düsseldorf.

Early examples of airline-operated buses in the United States included America West Airlines' service between Phoenix and Scottsdale, Arizona. The service was unusual in that the bus was driven onto the tarmac of the airfield and met the passengers before they entered the terminal building. Baggage was through-checked in both directions. The service was discontinued during a cost-cutting period. American Airlines operated bus service from several locations in the Dallas/Fort Worth area with full baggage check-in, but this service has also been discontinued.

Currently, Frontier Airlines operates bus service between Boulder, Colorado, and Denver Airport. Continental Express operates bus service between Newark and Lehigh Valley International Airports. Through-baggage check-in is offered in both directions.

United Airlines has made the largest commitment to bus service operated by an airline. The airline's Ground Link program is subtitled "One Reservation, One Ticket." Each bus trip purchased accrues 500 Mileage Plus miles. The off-site pickup areas are usually hotels, and no through-baggage check-in is provided. United Airlines currently provides through-ticketing service to 18 cities.

EMERGING RAIL TECHNOLOGY

A wide variety of rail services have been used for airport access in the last decade. These services range in level of specialization from the use of rapid transit equipment with virtually no accommodation for the baggage needs of the airline

passengers to the development of totally new equipment with automated baggage-container operations. The following concepts in rail technology are discussed below:

- Traditional rapid transit vehicle design,
- Commuter and standard intercity rail technology,
- High-speed rail technology, and
- Magnetic levitation (maglev) technology.

Traditional Rapid Transit Vehicle Design

Systems that use traditional rapid transit vehicle configurations include those serving Boston; Chicago; Washington, D.C.; Cleveland; and Atlanta. Each of these "heavy rail" systems operates with full high-platform format and uses third-rail power supply. Planned operations with rapid transit design include the Bay Area Rapid Transit (BART) system extension to San Francisco Airport. "Light rail" technology, with overhead catenary power supply, is currently in operation in systems serving airports in Baltimore and St. Louis (see Figure 6-21). An extension of the low platform, catenary-powered light rail system to serve Portland Airport is currently in design.

Systems in Europe that use traditional rapid transit design vehicles include the Piccadilly Line to Heathrow Airport in London. The RER in Paris and the S-Bahn in Munich and Frankfurt provide longer-distance regional services (similar to commuter rail) with major downtown distribution (similar to rapid transit).

Commuter and Standard Intercity Rail Technology

The most prevalent technology for airport rail access is the use of traditional commuter rail trains that are designed for use on a common track with freight and long-distance passenger



Figure 6-21. Air travelers in St. Louis are served with conventional light rail equipment.

rail trains. These commuter trains are designed with a heavier body than rapid transit trains, which are not designed to be used on the same track as traditional commuter rail trains. Commuter rail car design considerably constrains the ability of these systems to negotiate small-radius turns in comparison with light rail and people movers. The larger turning radius affects the extent to which commuter rail can be architecturally integrated with existing airport facilities.

In the United States, standard electrified rail technology is used only in service to Philadelphia International Airport (see Figure 6-22). The new service to Newark Airport will be operated with standard New Jersey Transit commuter rail equipment. Similar rail equipment is used by the Maryland Rail Commuter service (MARC) system serving Baltimore-Washington Airport. Other propulsion systems for airport access are diesel multiple-unit trains as proposed in Denver. Early consideration is now being given to the possibility of serving Raleigh-Durham International Airport with diesel multiple-unit commuter rail technology.

High-Speed Rail Technology

The operators of two European airports are investing heavily in new high-speed rail services, while other European operators are offering rail service that uses high-speed rights-of-way for a portion of their operation. In this concept, the airline passenger shares the same equipment provided for the national rail service. The French TGV, which operates in excess of 180 mph, was Europe's first high-speed rail service. Service was inaugurated to Paris' Charles de Gaulle Airport in 1996. As was discussed in Chapter 5, a new high-speed rail station has opened at Frankfurt Airport as part of an entirely new line connecting to Cologne. This high-speed rail service will have a travel time of 1 hr, compared with the current 2-hr travel time of the regular rail.

In the United States, the Baltimore-Washington Airport (and possibly in the future, Newark Airport) will be served

by Amtrak's new 150-mph rolling stock, to be inaugurated in 2000. The Newark rail station will be connected to the air terminals by an automated people mover; the Baltimore-Washington Airport rail station is currently connected to the air terminals by shuttle bus.

Maglev Technology

Initial proposals for use of maglev technology—in which trains are magnetically propelled and float in a magnetic field above the guideway—for airport access projects in Orlando, Pittsburgh, and Los Angeles have not been developed further. An early use of maglev technology to link the airport in Birmingham, England, with a parking facility has been abandoned. Similarly, maglev-technology systems had been proposed for the expansion of Frankfurt Airport, but they were also abandoned.

The most highly developed plans for maglev technology in U.S. airport access were proposed in Orlando, Florida. Extensive designs were developed for a maglev system between the landside terminal at Orlando Airport and a new terminal at International Drive, near, but not adjacent to, the Disney World complex. Extensive market forecasts indicated that the system would mainly be used as a tourist attraction rather than as a method of airport access. Even with fully developed use as an attraction, the capital costs could not be justified. Plans for the link had developed so far that a subsidy of more than \$90 million was included in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) to purchase the right-of-way for the project.

A group of industry leaders in Pittsburgh proposed that the federal government fund a maglev demonstration project between Pittsburgh Airport and the downtown. However, U.S. DOT scaled back the National Maglev Initiative to a smaller program, with less emphasis on actual demonstrations.

AUTOMATED PEOPLE-MOVER TECHNOLOGY

Automated people-mover technology is used at many airports for internal circulation rather than for regional airport ground access. At a limited number of airports, these internal systems are used to transport ground access passengers to connecting facilities. In a smaller number of cases, the people mover is used off airport property to make important regional connections.

Use of Automated People Movers as Circulation to Regional Ground Services

On-airport people movers are used at several airports to assist in connecting travelers with ground transportation services. In Chicago, users of the new international facility access the CTA airport station via the internal people mover, while all other users walk to the transit station in the central garage.



Photo: Matthew A. Coogan

Figure 6-22. Electrified commuter rail equipment is used to serve the Philadelphia International Airport.

The people mover at San Francisco Airport will primarily serve as an internal circulation system, connecting distant parking and rental car facilities on airport property. BART users from the new International and North Terminals will walk to the BART station, while users from the South and old International Terminals will have the option of using the people mover to access BART service.

At London Gatwick Airport, users of the rail system are connected to the North Terminal with a short people-mover shuttle service. This people mover is one of the few in the world that allows baggage carts on the moving vehicle (see Figure 6-23). The user can take the baggage cart directly from the baggage-pickup area of the North Terminal to the mezzanine level of the Gatwick Express rail station—a key element of the rail strategy.

Currently, rail users at Frankfurt Airport must enter the secured area of Terminal 1 and board a people mover to Terminal 2. With the construction of a new high-speed rail station several hundred feet farther from the existing station, a new people mover will transport passengers from the new station to Terminal 2, outside of the secured area.

At Paris' Charles de Gaulle Airport, two people-mover lines are planned. These lines will connect the high-speed rail transfer station with the adjacent Terminal 2 and with the old Terminal 1, which is almost a mile away. An experimental automated people-mover concept of continuously moving small vehicles was examined but abandoned.

Use of Automated People Movers for Off-Airport Connections

At present, there is only one application of people-mover technology to connect an airport with regional services off

airport—that which is between Paris Orly Airport and the regional RER Line B rail service about 3 mi away. An older monorail provides service to Tokyo International Airport Haneda. A new people mover, called the H-Bahn, is now under construction and will connect the Düsseldorf airport with a new station on the national high-speed rail line.

The first use of people-mover technology for regional connections in the United States is being implemented in Newark, New Jersey, connecting Newark Airport with the New Jersey Transit services operating along the Northeast Corridor rail line (see Figure 6-24). Amtrak trains are not currently scheduled to stop at the new station. The system at Newark Airport uses Swiss Von Roll technology, which consists of smaller vehicles than are used in most airport systems.

People-mover connections from airports to regional rail systems have been examined in Boston, Dallas/Fort Worth, Oakland, and Providence, and in earlier concepts for San Francisco.

The Port Authority of New York and New Jersey spent several years examining the concept of a people mover from JFK Airport to Jamaica Station, to LaGuardia Airport, and on to a new terminal at 59th Street in mid-Manhattan. The technology was of interest because the people mover can operate with very tight radius and curvature, making it a logical mode for integration into the airport terminal area. However, when Port Authority management examined the total cost of constructing a new facility just for airport users, the concept was dropped in favor of separate facilities for the two airports. For the segment from JFK Airport to Jamaica Station, the rubber-tired people-mover technology was rejected in favor of a rail technology that could, at some future point, offer passengers the convenience of traveling between Manhattan and the airport without mode or vehicle changes.

In place of the previously examined people mover between LaGuardia Airport and Manhattan, the responsible agencies



Photo: Matthew A. Coogan

Figure 6-23. Baggage carts are encouraged on the people mover between London Gatwick Airport's North Terminal and the rail station.



Photo: Matthew A. Coogan

Figure 6-24. The Swiss Von Roll people-mover technology will connect Newark International Airport with the New Jersey Transit on the Northeast Corridor.

have begun an alternatives analysis process to evaluate public transit improvements in the corridor between Lower and Midtown Manhattan and LaGuardia, focusing on proposed extensions of rapid transit lines in Manhattan and Queens.

ALTERNATIVE STRATEGIES FOR OFF-SITE AIRPORT CHECK-IN

Management of several major airports, such as Amsterdam's Schiphol Airport, is reviewing the concept of moving major airport functions to off-site "gateway" locations. At present, full off-site check-in services are available for only a small number of airports, including Zurich, Geneva, London Gatwick, and Hong Kong Airports, and starting later this year, for Heathrow Airport. Limited off-site check-in service is offered to Kansai International Airport in Osaka, Japan. Full-service off-site check-in has two components: management of the checked baggage and the process of checking in passengers by personnel not employed by the airlines. Recent technology advances have occurred in both areas.

Automating Check-In

At Frankfurt Airport, a new check-in facility is being implemented as part of the new high-speed rail station now under construction. However, Lufthansa German Airlines is in the process of negotiating with German Railways to speed the process of relocating major check-in functions from the airport to the rail stations of origin throughout the system.

A key element in the longer-term assignment of check-in functions to nonairline employees (such as railroad employees) is the simplification of the check-in function itself. As a first step in the creation of this systemwide process, Lufthansa has taken several steps to apply new technology to the check-in process. In 1998, Lufthansa began using automated check-in kiosks at Frankfurt Airport (see Figure 6-25). The kiosks are unique in that they allow the user to check baggage, to receive a baggage claim check and tag, and to apply the tag to the baggage. Several airlines, such as Alaska and Continental Airlines, have started to use similar kiosks at U.S. airports.



Photo: Matthew A. Coogan

Figure 6-25. Automated-baggage and passenger check-in systems are being implemented at Frankfurt International Airport.

In September 1998, Lufthansa took a small step in creating the new system of rail station check-in. At five railroad stations in Germany (in Düsseldorf, Cologne, Bonn, Würzburg, and Nuremberg), check-in services are offered between 7 P.M. and 9 P.M. Called the "moonlight check-in," the system is seen as a building block toward a wider system of decentralized intermodal check-in services. In a similar move, Lufthansa will check in baggage at 12 German rail stations generally between 6 P.M. and 9 P.M. for flights the next morning.

Management at Amsterdam's Schiphol Airport is exploring the concept of off-site gateways, where the full check-in process would occur. As part its overall effort in this area, Schiphol Airport management installed the first automated check-in kiosks in March 1999. Unlike the Frankfurt airport's automated check-in kiosks, which were developed by Lufthansa, the Schiphol airport's kiosks were developed by the airport authority, with the goal of making the kiosks available to all interested airlines. No baggage check-in is offered at present. The user is identified by a major credit card, passport, or frequent flyer card. Use of automated kiosks for those passengers without baggage is increasing at both European and U.S. airports.

CHAPTER 7

INSTITUTIONAL ENVIRONMENT AND FACTORS AFFECTING PUBLIC TRANSPORTATION ACCESS TO LARGE U.S. AIRPORTS

This chapter provides an overview of the key legal, financial, institutional, and jurisdictional factors affecting public transportation to airports. Three major areas of institutional determinants to financing airport access projects are reviewed: (1) federal funding and oversight, specifically FAA policies related to the financial support of airport ground transportation projects; (2) funding of surface transportation projects by FHWA and FTA and by state governments; and (3) contractual agreements between airport operators and airlines that limit the use of airport funds. FAA’s policies with regard to use of airport revenue now allow greater flexibility in funding airport access projects (this funding flexibility will be discussed later in this chapter).

OVERVIEW AIRPORT LEGAL STRUCTURE AND FINANCIAL OPERATIONS

This section provides an overview of the legal structure of most U.S. airports, a discussion of the factors governing U.S. airport financial operations, and a discussion of the sources of funding for projects at U.S. airports.

Legal Structure of U.S. Airports

Most U.S. airports are operated as either independent not-for-profit entities with oversight by a politically appointed authority or as self-sustaining enterprise funds of a governmental entity such as a county, city, or state government. The form of governance for the 100 busiest airports (in terms of passengers) in the U.S. is as follows (61):

Authority	4%
City	40%
Regional	23%
County	15%
State	9%
Other	9%
	<hr/>
	100%

Airports operated as enterprise funds of governmental entities may be overseen by boards or commissions structured as decision-making entities, operating within the legal and political framework of the sponsoring jurisdiction.

Airport authorities exist in a variety of forms, and their specific powers and responsibilities are established by their enabling legislation. Some airport authorities are independent public bodies created by state legislation; others are municipal corporations or agencies created by one or more local jurisdictions under general state statutes governing the establishment of independent authorities. Many airport authorities sponsored by state or local legislation operate relatively independently of their governmental sponsors, while remaining responsive to political concerns and priorities. In other cases, the sponsoring jurisdiction retains some oversight of airport operation, such as approval of operating budgets and bond issues.

Factors Governing Airport Financial Operations

Most of the sources of capital available to finance airport improvements have either direct or indirect external restrictions on their use (e.g., federal or contractual restrictions). This section describes those external restrictions and provides the context for airport access funding from different sources, which will be discussed later.

Figure 7-1 reflects the typical factors that govern airport financial operations. Those factors include (1) federal regulations and policies and grant assurances made by airport sponsors, (2) the airport operator’s authorizing legislation, (3) the bond indenture for the airport, and (4) the airport’s airline use-and-lease agreements. The airport’s concession agreement(s) also affect the airport operator’s net revenue and financial capacity.

Federal Regulations and Policies

The U.S. Congress has passed various legislation since 1982 establishing the Airport Improvement Program (AIP) grant funding and the authority for airport operators (1) to levy passenger facility charges (PFCs) and (2) to govern how airport revenue is generated and used. The most recent legislation was the Wendell H. Ford Aviation Investment and Reform Act for the 21st Century, also known as the FAA Reauthorization, or AIR-21. The act was signed into law on April 5, 2000. U.S. DOT and FAA have established regulations and issued policy guidance to provide specific direction to airport operators

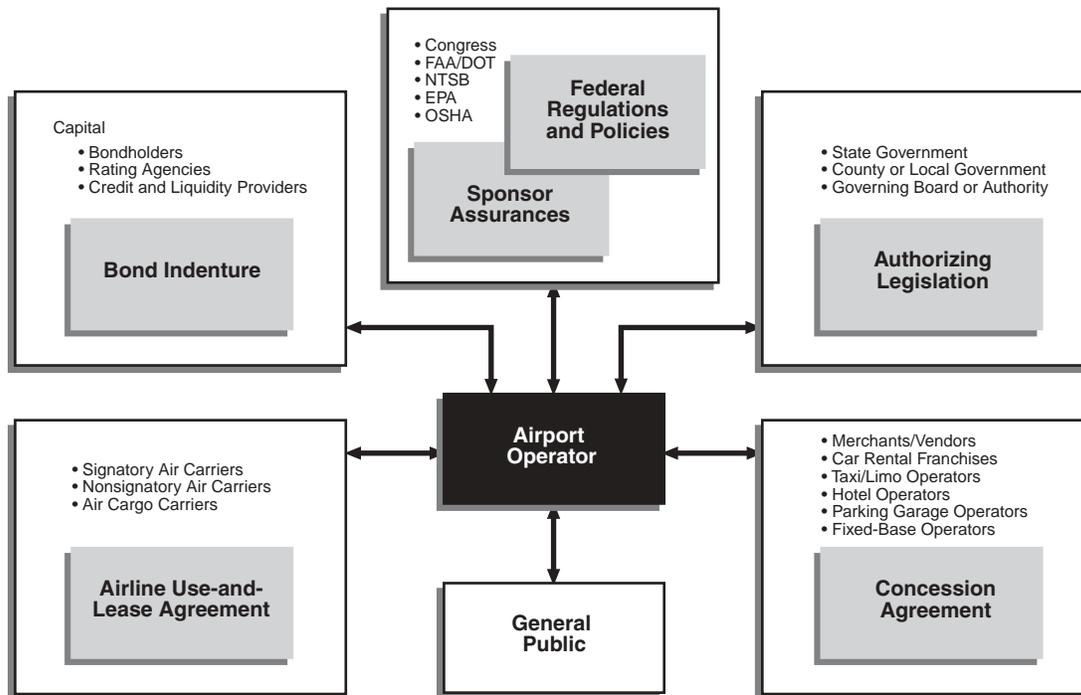


Figure 7-1. Factors governing airport financial operations.

NOTES: FAA/DOT—Federal Aviation Administration/Department of Transportation
 NTSB—National Transportation Safety Board
 EPA—Environmental Protection Agency
 OSHA—Occupational Safety and Health Administration

regarding eligibility and use of AIP funds, PFC revenue, and airport revenue. U.S. DOT and FAA regulations and policies regarding airport rates and charges, which relate to how airport revenue is generated, have also been issued.

Authorizing Legislation

Airport operators that are independent entities or enterprise funds of a city, county, or state government typically are governed by authorizing legislation or a local charter that establishes the airport operator's organizational structure, responsibilities, and powers. The authorizing legislation may specify facilities, such as airport access roads, that the airport operator is responsible for developing or maintaining, or both.

Bond Indenture

The bond indenture—also called a bond resolution or bond ordinance—provides the legal basis for issuing airport revenue bonds and defines the terms under which additional bonds might be issued, including the need for revenue-generating projects. The bond indenture defines what may or may not be included in the definition and computation of airport revenues and expenses. The indenture establishes various funds and accounts for the payment of interest and principal on the bonds from airport revenues; establishes the priority of payments for

all of the airport operator's obligations; and sets forth various covenants between the issuing entity and the bondholders, including a rate covenant requiring the airport operator to set rates and charges to produce specified levels of revenues. Some airport bond indentures may also include principles to guide the establishment of rates and charges for the use of airport facilities.

Airline Agreement

An airport–airline agreement generally stipulates the rights, privileges, and obligations of the airport operator and the airlines serving the airport and sets forth the manner in which the rentals, fees, and charges paid by the airlines for use of the airport are calculated and adjusted. Parties to use-and-lease agreements are called “signatory airlines.”

Many airline agreements contain provisions that require a certain number or percentage of the signatory airlines to approve or disapprove certain decisions of the airport operator, most often those decisions involving airport capital expenditures. These provisions are known as “Majority-in-Interest” provisions (MII) and are designed to give the signatory airlines some control over the long-term financial obligations undertaken by the airport operator.

Some airports, however, are not governed by such agreements; instead, rates are established by ordinance or regulation. In those instances, the airport operator typically adopts

a policy setting forth the procedures to be used in calculating user rentals, fees, and charges and applies those procedures consistently from year to year in enacting the rate ordinance and calculating airport charges. The FAA's *Policy Regarding Airport Rates and Charges* broadly governs airport rate-setting in the absence of an airline agreement and dispute resolution (62).

Concession Agreements

Many airport operators also enter into various agreements with providers of nonaeronautical services, such as parking garage operators; rental car agencies; and merchants and vendors of food, news items, and gifts. These agreements are often the largest source of nonairline revenues at most airports. The agreements do not, however, govern how an airport operator can use those revenues.

Sources of Funding

Major airports in the United States are required to be financially self-sustaining under the FAA grant assurances. Rentals, fees, and charges at these airports must be set so that revenues are sufficient to cover all operating and capital costs, including retirement of debt. The capital requirements of airports are significant today and are expected to increase in the future. The capital needs of airports are primarily driven by

- Traffic growth and the associated need to expand facilities;
- Normal wear and tear of facilities as a result of use and age; and
- Changing technology, particularly aircraft technology, rendering existing facilities functionally obsolete.

All the assessments of the future airport capital needs that have been conducted in recent years (e.g., by the General Accounting Office, Airports Council International, and Air Transport Association) indicate that growing capital investments will be required for airports to keep pace with their traditional roles. The main sources of funds to build airport projects include the following:

1. **Internally generated capital resulting from retained airport revenues.** Airport operators charge and collect rentals, fees, and charges for the lease and use of facilities to passenger and cargo airlines, concessionaires, and others providing airport support services. The operating and maintenance costs and portions of the capital costs of projects at major airports are recovered through the rentals, fees, and charges collected from airlines, concessionaires, and other tenants of the airport. Rentals, fees, and charges collected from tenants of airport facilities are also often the primary source of funds for repayment of principal and interest on bonds.

2. **Bond proceeds.** Four basic types of bonds are issued to fund airport capital improvements, including (1) general airport revenue bonds (GARBs) secured by the revenues of the airport and other revenues as may be defined in the bond indenture; (2) bonds backed either solely by PFC revenues or by PFC revenues and airport revenues generated by rentals, fees, and charges; (3) special facility bonds backed solely by revenues from a facility constructed with proceeds of those bonds; and (4) general obligation bonds supported by the overall tax base of the issuing entity (the airport sponsor).
3. **PFC revenues.** Subject to authorization by FAA, commercial service airports are allowed to impose a \$1, \$2, \$3, \$4, or \$4.50 PFC per enplaning passenger. The \$4 and \$4.50 PFC amounts are pursuant to the AIR-21 FAA reauthorization, and FAA guidance was issued in draft form in September 2000. PFC revenues may be used as they are received (on a pay-as-you-go basis) to directly pay for approved capital projects, or they may be used to pay debt service on bonds backed by PFC revenues.
4. **Federal grants.** Federal AIP grants administered by FAA are funded by aviation-user taxes. AIP grants are made available to airport operators in two forms: (1) entitlement funds, which are apportioned to airports based on levels of passenger traffic and landed weight (for cargo entitlement funds); and (2) discretionary funds, which are distributed based on the ranking of the airport's projects in relation to other projects deemed most important for improving the national air transportation system. Federal funding is also occasionally provided for airport surface transportation projects by FHWA and FTA.
5. **State and local grants. State funding for airport and aviation-related projects** comes from a variety of sources—outright grants, matching share for federal AIP grants, registration and licensing fees, and dedicated or special taxes such as fuel taxes. Support from local government generally takes the form of general taxes. State or local grants may be provided to fund capital improvements at an airport, such as roadway and access projects.

The distribution of funding sources for large- and medium-hub airports nationwide in 1996, the most recent year for which such information is available, is summarized in Table 7-1.

As shown in the table, airport revenue bonds constitute the most significant source of funding, accounting for 62.1 percent of total funding for airport capital projects in 1996. In that year, PFCs accounted for 18.0 percent, and AIP grants accounted for 10.6 percent of the total; airport-retained earnings, special facility bonds, and state and local grants each provided less than 5 percent of total funding for airport capital projects.

In developing any strategy for funding off-airport access projects, it is important to recognize the hurdles uniquely associated with each funding source, and to recognize the exter-

TABLE 7-1 1996 funding sources for large- and medium-hub U.S. airports

Funding source	Amount (millions)	Share
Airport revenue bonds	\$3,468	62.1%
Passenger facility charges	1,005	18.0
Federal AIP grants	592	10.6
Airport retained earnings	257	4.6
Special facility bonds	167	3.0
State and local grants	95	1.7
Total	\$5,584	100.0%

SOURCE: General Accounting Office. *Airport Financing, Comparing Funding Sources with Planned Development*. GAO: Washington, D.C. (1998).

nal approvals required for each, if any. Also, certain funding sources, such as internally generated airport revenue, may not require external approval but are subject to sanction-oriented after-the-fact reviews by external parties, namely FAA. Federal funding and oversight and contractual agreements between airport operators and airlines that limit the use of airport funds are discussed below.

FEDERAL FUNDING AND FINANCIAL OVERSIGHT OF AIRPORTS

This summary of federal funding and financial oversight of airports focuses specifically on AIP grants, PFCs, and use of airport revenue.

AIP Grants

Federal Legislation

Congress enacted the following legislation that makes federal grants available to fund airport capital projects and that governs grant eligibility.

Airway Revenue Act of 1970. This act established the Airport and Airway Trust Fund, which provides the revenues used to fund the federal (AIP) grant program that was subsequently established in 1982. The trust fund is funded from taxes or user fees, including the airline ticket tax, a tax on air-freight waybills, an international departure fee, and a tax on general aviation gasoline and jet fuel.

Airport and Airway Improvement Act of 1982 (AAIA), as amended. AAIA established AIP. In 1994, AAIA was recodified at Chapter 471 of Title 49, United States Code. Section 505(a) of AAIA authorizes the FAA Administrator to make grants to assist in the development of public-use airports served by air carriers, commuters, and general aviation. AAIA authorized funding levels, specified eligible airport sponsors and projects, and provided the formula for distributing AIP funds. AIP authorization amounts for single-year or multiyear

periods have subsequently been specified in legislation enacted in 1983, 1987, 1990, 1994, 1996, 1997, 1999, and 2000.

U.S. DOT and FAA Implementation

U.S. DOT and FAA have issued orders and advisory circulars to provide guidance and to establish policies and procedures to be used in the administration of AIP grants. Specific eligibility is described below.

Eligible access roads. Access roads and related facilities are eligible for AIP grants provided that

- The access road may extend only to the nearest public highway of sufficient capacity to accommodate airport traffic.
- The access road must be located on the airport or within a right-of-way acquired by the airport sponsor.
- The access road must exclusively serve airport traffic. Any section of the roadway that does not exclusively serve airport traffic is ineligible.
- More than one access road is eligible if the airport surface traffic is of sufficient volume to require more than one road.
- Related facilities such as acceleration and deceleration lanes, exit and entrance ramps, street lighting, and bus stops are also eligible when they are a necessary part of an eligible road.

The AIR-21 FAA reauthorization contains a provision that if a large- or medium-hub airport operator applies for and is granted approval to charge a \$4 or \$4.50 PFC, then that airport operator must forego 75 percent of its passenger-based entitlements.

Ineligible access roads. Access roads and related facilities that are not eligible for AIP funding include

- Roads necessary to maintain FAA facilities installed under the Facilities and Equipment Program (which is budgeted separately from AIP);
- Roads exclusively serving industrial or non-aviation-related areas or facilities; and
- Roads exclusively used for connecting parking facilities to an access road.

Eligible rapid transit facilities. Facilities within the airport boundary that are necessary to provide a connection to a rapid transit system may be eligible if they will primarily serve the airport. Such projects are evaluated on a case-by-case basis by the Program Guidance Branch of the FAA Office of Airport Planning and Programming. In PFC decisions on fixed guideway access projects that involve construction of rail or guideway segments, FAA has relied on the access road guidance for reestablishing eligibility. Moreover, FAA has

made it clear that where an on-airport facility would have both airport and general use, AIP and PFC funding could not be used for any component of the project that would be subject to general use because the project would not be for exclusive airport use.

Sponsor Assurances

Airport sponsors and operators must give certain assurances to FAA in order to receive federal grants. There are 37 assurances that must be certified by the sponsor as a condition of grant approval depending on the type or scope of the project for which the grant is being sought. An airport operator cannot discharge its commitment to abide by these grant assurances simply by repaying all of the federal grants received. Examples of assurances that directly affect the legal and financial structure of airports follow.

Assurance of consideration of local interest. Consideration of local interest assures that the sponsor has given fair consideration to the interests of local communities in which the project may be located.

Assurance that public hearings have been held. Holding public hearings assures that, in projects involving the location of an airport, an airport runway, or a major runway extension, the airport operator has afforded the opportunity for public hearings for the purpose of considering the economic, social, and environmental effects of the project on the community and the consistency of the project with the planning goals and objectives of the community.

Assurance of consultation with users. Consulting users assures that affected parties using the airport facilities are afforded a reasonable opportunity to provide input.

Assurance of economic nondiscrimination. Economic nondiscrimination assures that the airport will be operated for public use on fair and reasonable terms and that those entities engaged in aeronautical activities at the airport are providing services on a fair, equal, and not unjustly discriminatory basis and are charging fair, reasonable, and not unjustly discriminatory prices for those services.

Assurance of nonexclusive right of use. Nonexclusive right of use assures that the airport operator will not permit exclusive use of its aeronautical facilities by those entities providing aeronautical services.

Assurance of fee rental structure. Fee rental structure assures that the airport fee and rental structure will be set so that they make the airport a self-sustaining operating entity.

Assurance of nondiversion of airport revenues. Nondiversion of airport revenues assures that all revenues generated by the airport and local taxes on aviation fuel will be expended on the operating and capital costs of the airport or other facilities that are directly and substantially related to aeronautical activity and that are owned or operated by the operator of the airport.

Passenger Facility Charges

Federal Legislation

In 1990, the U.S. Congress enacted legislation to provide airports with an additional source of funding for capital projects, subject to FAA approval, in the form of PFCs. The Aviation Safety and Capacity Expansion Act of 1990 (recodified at §0177 of Title 49, United States Code) required U.S. DOT to issue regulations under which a public agency may be authorized to impose a PFC of \$1, \$2, or \$3 per enplaned passenger at commercial airports it controls. Under this act, the airport-related projects that are eligible preserve or enhance safety, capacity, or security of the national air transportation system; reduce noise from an airport that is part of the system; or furnish opportunities for enhanced competition between or among air carriers.

The AIR-21 FAA reauthorization allowing airports to collect \$4 and \$4.50 PFC amounts includes certain additional eligibility requirements on the amounts that are more than \$3. Large- and medium-hub airport operators must demonstrate that (1) a project will make significant contribution to improving safety and security, to increasing competition, to reducing current or anticipated congestion, or to reducing the impact of noise; and (2) the project cannot otherwise be paid from AIP. For surface or terminal projects, airport operators must have already made adequate provision for financing of airside needs.

U.S. DOT and FAA Implementation

In 1991, FAA issued a final rule regulating implementation of the Aviation Safety and Capacity Expansion Act of 1990. According to the final rule, ground transportation projects are eligible for PFC funding if the public agency owns or acquires the right-of-way and any necessary land. Under the rule, eligibility for ground transportation projects is identical to AIP eligibility (ownership is also necessary for project eligibility under AIP).

The final rule does not set any eligibility restrictions on the mode of transportation for airport access projects, nor does it impose any requirements on the geographical proximity of the project to the airport. The final rule states that these issues will be reviewed on a case-by-case basis as part of the FAA Administrator's review and approval of an application to use PFC revenue.

FAA had issued draft guidance regarding implementation of AIR-21 as of September 2000, so specific policies regarding applicability of the legislation to ground transportation projects were not available.

Use of Airport Revenues

Four federal statutes govern the use of airport revenue:

1. **Airport and Airway Improvement Act of 1982, as amended.** Section 511(a)(12) of AAIA established the general requirement for use of airport revenue, directing airport operators to “use all revenues generated by the airport for the capital or operating costs of the airport, the local airport system, or other local facilities which are owned or operated by the owner or operator of the airport and directly related to the actual transportation of passengers or property.”
2. **Airport and Airway Safety and Capacity Expansion Act of 1987.** Among other provisions, this act narrowed the permitted uses of airport revenues to non-airport facilities that are “substantially” as well as directly related to actual air transportation.
3. **FAA Authorization Act of 1994.** This act strengthened enforcement of revenue-use requirements and required annual reporting of airport finances and amounts paid to other units of government. Section 110 added a policy statement concerning the preexisting requirement that airports be as self-sustaining as possible.
4. **FAA Authorization Act of 1996.** This act codified the preexisting grant assurance–based revenue use requirement and expanded the application of the revenue-use restriction to any airport that has received federal assistance.

U.S. DOT and FAA Implementation

On February 16, 1999, FAA issued its final policy, *Policy Regarding Airport Rates and Charges*, concerning the use of airport revenue. The final policy clarifies a number of procedural and substantive rules that have been in effect over the last 17 years. Key provisions of the final policy include the following.

Ground access capital costs. Airport revenue may be used for the capital costs of an airport ground access project or for the part of a local facility that is owned or operated by the airport owner or operator and is directly and substantially related to the air transportation of passengers or property, including use by airport visitors and employees.

As an example, the final policy summarizes FAA’s decision regarding the use of airport revenue to finance construction of the rail link between San Francisco Airport and the BART rail system extension running past the airport. In that decision, FAA approved the use of airport revenues to pay for the actual costs of construction and equipment asso-

ciated with an airport BART station at the terminal building and a rail connector between the airport station and the BART extension. The structures and equipment (1) are to be located entirely on airport property, (2) are owned by the airport sponsor, (3) are necessary to connect the airport to a local transit system, and (4) are directly and substantially related to the air transportation of passengers (which FAA defines to include airport visitors and employees) or property. Whereas the costs of a facility that is only partly airport-related are generally ineligible for use of AIP or PFC funding, the airport-related portion of the costs may be eligible for the use of airport revenues on a prorated basis. In the BART case, since the terminal building and rail connector were to be exclusively used by airport passengers, the total costs of these could be paid with airport revenues.

Ground access operating costs. Airport revenue may also be used to pay the *operating* costs of an airport ground access project that can be considered an airport capital project or, as is the case for capital costs, the operating costs of the part of a local facility that is owned or operated by the airport owner or operator and is directly and substantially related to the air transportation of passengers or property. Allowing airport revenues to be used to pay the operating costs of a ground access project represents a change in FAA policy.

Use of property for publicly owned transit projects. Airport property can be made available at less than fair market value for public transit terminals, rights-of-way, and related facilities without being considered a violation of federal statutes governing airport finances if (1) the transit system is publicly owned and operated (or operated by contract on behalf of the public owner) and (2) the facilities are directly and substantially related to the air transportation of passengers or property. A lease of nominal value would be consistent with the requirement for airports to be self-sustaining.

Use of property for private transit projects. The final policy states that, generally, private ground transportation services are comparable to private taxicab and limousine services and are charged fees for the nonaeronautical use of the airport. These private entities are commercial enterprises that operate for profit, that are not supported by general taxpayer funds, and that are a significant source of revenue for the airport. However, in cases in which publicly owned transit services are limited and in which a private transit service (bus, rail, or ferry) provides the primary source of public transportation, the airport operator may make airport property available at less than fair market value.

FEDERAL AND STATE FUNDING FOR AIRPORT ACCESS PROJECTS

Certain airport projects are also eligible for federal grants and credit assistance that are available for surface transporta-

tion projects through FHWA and FTA. However, there is tremendous demand for those grants. Airport projects must be given high enough priority on a State's Transportation Improvement Program (STIP) to actually receive funding. Because airport projects are often lower in priority, given the number of other funding sources upon which airport operators can draw, it is unusual for airport projects to receive federal grants for surface transportation projects.

The federal-aid highway program transfers highway funding raised in federal gas taxes from the Highway Trust Fund back to the states. Unlike most federal programs, which authorize and appropriate funds for a single-year only, federal-aid highway funding is distributed in multiyear authorization acts. The most recent bill authorizing funding was the Transportation Equity Act for the 21st Century (TEA-21), enacted June 9, 1998.

Generally federal-aid highway funds are apportioned to states by predetermined formulas dictated by legislation. These apportioned funds are further divided into fund categories, each with specific eligibility and matching requirements. A much smaller proportion of funds is administratively allocated by FHWA to specific states or projects, or both. Congress sometimes reduces the amount available to interested project sponsors by earmarking the allocated funds.

Federal Grants for Surface Transportation Projects

Two factors affect whether federal-aid funds can be used for airport access:

1. **Underlying funding eligibility**—For what kinds of projects can the funds be used? In most cases, this is determined by the legislation.
2. **Funding availability**—Will the entity that controls use of the funds choose to use the funds on airport-access projects?

When airports are interested in seeking federal-aid funding for surface transportation projects, there are three possible points of contact:

1. The **MPO** in the metropolitan area in which the airport is located. The relevant MPO usually has the best handle on the local funding picture and on the potential eligibility of highway funding. Any area with a population of 50,000 or more is likely to have an MPO. The MPO develops the local Transportation Improvement Program (TIP) that is incorporated into the STIP. The STIP identifies all federal-aid projects for 3 fiscal years at a minimum.
2. The **DOT** in the state in which the airport is located. The state DOT will program all apportioned federal-aid highway funds that are not set aside for metropolitan areas or otherwise encumbered; however, depending on the

point in the STIP process, many of these funds will have already have been earmarked for other projects.

3. **FHWA**, and possibly **U.S. DOT**, for any allocated fund categories. An example of these categories is the TEA-21 border infrastructure program that sets aside funds for a limited number of border improvement projects.

Specific information on several of the federal funding programs and projects that provide funds for surface transportation projects is shown in Table 7-2, which is based on information provided by FHWA's Office of Program Administration. The list of programs and projects is not intended to be all-inclusive, but is meant to identify those programs that are applicable to surface transportation in and around airports. All programs and projects are part of the Highway Trust Fund. The amounts in the "Funding" column were authorized by TEA-21. The program offices listed in the "Comments and additional information" column should be consulted for further information.

Major Funding Categories

The major funding categories are as follows:

- The Surface Transportation Program (STP) is the most flexible category of funding. STP contains mandatory set-asides for safety, as well as set-asides for areas with populations of more than 200,000. The latter set-asides cannot be spent without approval of the local MPO;
- The Congestion Mitigation and Air Quality Improvement Program (CMAQ);
- The National Highway System (NHS) program; and
- The Bridge Discretionary Program.

Eligibility and other information about these and other funding categories can be found in FHWA's *Guide to Federal-Aid Programs and Projects* (online at www.fhwa.dot.gov/infrastructure/progadmin/covert21.htm).

In addition to FHWA funding sources, FTA provides grant moneys for eligible transit-related access projects. A large portion of FTA funds are dedicated to bus and rail transit projects aimed at alleviating highway congestion in and around major metropolitan areas.

TEA-21 has authorized the distribution of FTA funds that are allocated to states through the following:

- **Formula Program**—available for all transit purposes including planning, the purchase of bus and railcars, facility repair and construction, maintenance, and operating expenses.
- **Capital Program**—available for new transit projects, bus and bus-facility investments, the modernization of fixed guideway systems, and metropolitan planning. (The capital funds are largely earmarked by the Congress through annual appropriations.)

TABLE 7-2 Federal-aid programs and projects

Program project	Funding	Eligible projects	Coordination			Comments and additional information
			State	MPO	Other	
Surface Transportation Program (STP) (a)	Apportionment (\$33.3 billion for FYs 1998-2003)	Construction, rehabilitation, resurfacing, traffic and other improvements for highways and bridges	x	x	x (b)	STP funds apportioned according to a formula: 25% based on the ratio of state lanes to U.S. lane miles, 35% based on the ratio of state tax payments to U.S tax payments into Highway Trust Fund, 40% based on the ratio of state vehicle miles traveled to all U.S miles traveled. Contact the Office of Metropolitan Planning (HEMP) or the Office of Program Administration (HIPA)
STP Set-Aside for Safety Improvements	10% of STP apportionments	Safety improvements on any public road including rail and highway crossings and hazard elimination projects	x	x		Contact the Office of Highway Safety Infrastructure (HMHS) or the Office of Program Administration (HIPA)
STP Set-Aside for Transportation Enhancements	10% of STP apportionments	Pedestrian facilities, landscaping, environmental mitigation, control of outdoor advertising, etc.	x			Contact the Office of Human Environment (HEHE)
Congestion Mitigation and Air Quality Improvement Program	\$8.1 billion authorized for FYs 1998-2003 (based on county air quality)	Control measures for Clean Air Act projects, traffic management, intermodal freight projects, fare/fee subsidy programs	x	x		If a state has no ozone or carbon monoxide problems, the funds may be used for STP eligible purposes. Contact the Office of Natural Environment (HENE)
Metropolitan Planning Funds	Apportioned to states based on the size of urban population	Inventories or routes for condition and capacity, predictions of employment, population, and growth to assess current and future transportation needs	x	x		MPOs are responsible for developing a long-range transportation plan and transportation improvement plan. Contact the Office of Metropolitan Planning (HEMP)
National Corridor Planning and Development Program	\$140 million for each of FYs 1999-2003	Feasibility studies, corridor planning and design, location and routing studies, environmental review and construction	x	x		Contact the Office of Intermodal and Statewide Programs (HESP)
Intelligent Transportation Systems Integration (c)	\$679 million for FYs 1998-2003	In metropolitan areas, funds are for integrating systems; outside metropolitan areas, funds may be used for installation costs	x			At least 10% of the funding will be directed toward rural areas
Surface Transportation Research	\$592 million authorized for FYs 1998-2003 (d)	R&D and technology transfer activities related to motor carrier transportation, transportation planning and development, and the effect of state laws on the above	x	x		An Advanced Research Program has also been established addressing longer-term, higher-risk research. Contact the Office of Infrastructure Research and Development (HRDI)
State and Community Highway Safety Grants	\$932.5 million authorized for FYs 1998-2003	Funds apportioned to states to pay for non-construction costs of highway safety programs aimed at reducing injury, death, and property damage from motor vehicle accidents	x	x		At least 40% of the apportionments to each state must be used for local traffic safety problems. Contact the Office of National and International Safety Programs (HMSP)
High Priority Projects	\$9 billion authorized for FYs 1998-2003	Studies, engineering, construction, etc.	x	x		1,850 projects have been approved for funding. Contact the Office of Program Administration (HIPA)

NOTES: (a) A separate STP program has been established for urban areas with more than 200,000 people. The funds in this program are distributed on the basis of population unless other criteria are approved by the Secretary of Transportation.
 (b) Certain projects applied for by urban areas with a population of more than 200,000 are subject to FHWA approval.
 (c) ITS Program includes a separate program for R&D with authorized funds of \$603.2 million for FYs 1998-2003.
 (d) Funding for the Surface Transportation Research Program also includes funding for the Surface Transportation-Environment Cooperative Research Program.

SOURCE: FHWA Office of Program Administration. *A Guide to Federal-Aid Programs and Projects*. FHWA: Washington, D.C. (1999).

- **Research and Technology Program**—available for researching transportation methods and for developing technologies that improve air quality, reduce traffic congestion, increase safety, and so forth.

The majority of the recent apportionments of federal monies have been to the Formula and Capital Programs. The funds are apportioned to state governors by a statutory formula, and the governors are responsible for allocating the moneys.

The Formula Program is further divided into Urbanized Area and Nonurbanized Area Programs, an Over-the-Road Bus Accessibility Program, an Alaska Railroad Program, and the Elderly and Persons with Disabilities Formula Program.

The Capital Program is composed of three programs: the Bus Program, the Fixed Guideway Modernization Program, and the Major Capital Investments (“New Starts”) Program. The Bus Program provides funding for acquisition of bus and rolling stock and ancillary equipment and for construction of bus facilities. The Fixed Guideway Modernization Program provides funding for repair and rehabilitation of existing fixed guideway systems. The New Starts Program provides funding for construction of new fixed guideways and rail extensions: subways, light rail, commuter rail, and busways. It is the New Starts Program that is the most important source of potential FTA funding for rail transit to airports. However, current demand for these New Starts funds greatly exceeds available resources. As of spring 2000, of the approximately 190 proposed projects in the New Starts pipeline that are candidates for FTA funding, nearly 30 feature a potential fixed guideway connection to an airport.

The Research and Technology Program is divided into the Metropolitan Planning and State Planning and Research Programs, both of which receive funds apportioned by a statutory formula to governors, who in turn allocate these funds to MPOs in urban areas or to state representatives in rural areas. The Rural Transit Assistance Program is the program in the Research and Technology Program responsible for all research transportation initiatives.

Two new (as of 1999) FTA funding programs are the Job Access and Reverse Commute Program to provide transportation services for welfare reform initiatives and the Clean Fuels Formula Program (part of the Formula Program) to assist with air quality improvement and pollution prevention.

Information on FTA funding sources can be found online (www.fta.gov/).

Federal Credit Assistance

The Transportation Infrastructure Finance and Innovation Act (TIFIA), created as part of TEA-21, established a direct federal credit program. TIFIA authorizes the U.S. DOT to provide direct loans, standby lines of credit, and loan guarantees to public and private sponsors of large surface transportation projects that meet certain eligibility criteria. Project sponsors

of highway, mass transit, passenger rail, and intermodal facilities must submit an application to U.S. DOT for approval of funding assistance. TIFIA funding is limited and projects are selected on a competitive basis. U.S. DOT has established a Steering Committee and Working Group composed of representatives from the Office of the Secretary of Transportation, FHWA, FTA, U.S. DOT, and other agencies to coordinate the program. Coordination includes evaluating applications, selecting projects, obligating funds, and negotiating credit arrangements.

The program authorizes funds to be disbursed in the form of loans, loan guarantees, and lines of credit. The budgetary cost to the federal government is based on the estimated present value of default losses associated with federal credit instruments. For federal fiscal year 1999, TIFIA provided for approximately \$80 million to fund the subsidy costs associated with a total of \$1.6 billion of direct loans, loan guarantees, and lines of credit. The assistance is provided to either public or private sponsors, but the projects must be “of national significance.” A credit rating or preliminary opinion letter from a rating agency indicating that the project’s senior debt obligations have the potential of being investment grade is required with an application. Eligibility and other information about these and other funding categories can be found in the FHWA’s *Guide to Federal-Aid Programs and Projects* (online at www.fhwa.dot.gov/infrastructure/progadmin/covert21.htm).

To be eligible to receive TIFIA credit assistance, a project must meet the following five criteria:

1. The project must be included in a state transportation plan; before an agreement is made for federal credit assistance, the project must be in an approved STIP.
2. The entity undertaking the project must submit a project application to the U.S. Secretary of Transportation.
3. Eligible project costs must equal and exceed the lesser of \$100 million or 50 percent of the amount of federal-aid highway funds apportioned to the states for the most recently completed fiscal year.
4. Project financing must be repayable in part or in whole from tolls, user fees, or other dedicated revenue sources.
5. If the project is not undertaken by a state or local government or an agency or instrumentality of a state or local government, the project must be included in both the state transportation plan and an approved STIP.

More information about TIFIA eligibility and credit products can be found on the TIFIA website (tifa.fhwa.dot.gov/tifa).

State-Based Credit Assistance Programs

All of the following programs are state-directed programs enabled through federal-aid funding. The best point of contact is the relevant state DOT.

State Infrastructure Bank (SIB) Program

The National Highway System Designation Act of 1995 (popularly known as the NHS Act) enabled states to capitalize transportation credit assistance banks modeled on wastewater State Revolving Loan Funds. The SIB program provides loans, credit enhancement, and other forms of assistance (such as bond banks) to eligible surface transportation projects. Thirty-nine states have participated in the NHS pilot. In TEA-21, Congress allowed only four states—Missouri, Florida, Rhode Island, and California—to use new TEA-21 funding for capitalization. Since program implementation and capitalization levels vary from state to state, the best source of information about SIB assistance is the relevant state DOT. Information about general SIB programs is available online (www.fhwa.dot.gov/innovativefinance/sib.htm).

Section 129 Loan (Formerly Section 1012 Loan)

The NHS Act codified a pilot program under the previous authorization that permitted state DOTs to loan federal-aid highway funds to projects with dedicated revenue sources. Projects must be eligible for surface transportation funding. Once repaid to the state DOT, funds can be used for any eligible surface transportation project and do not have to follow federal requirements. Guidance for this lending program is available online (www.fhwa.dot.gov/innovativefinance/ifg.htm).

GARVEE Bonds and Transit GARVEEs

The NHS Act also permits federal-aid funds to be used for debt-service and debt-issuance costs. This permits states to raise funds for current projects by issuing bonds backed by future federal-aid highway funds. At least four states have issued highway bonds backed by future federal-aid funding since June 1998. More information about GARVEEs, including descriptions of past and current transactions, can be found in FHWA's *Innovative Finance Quarterly* (available online at www.fhwa.dot.gov/innovativefinance/ifpubs.htm).

Environmental Implications of Federal Funding for Airport Access Projects

Funding for airport access projects is subject to the provisions of both the National Environmental Policy Act (NEPA) and the Clean Air Act Amendments of 1990 (CAAA). NEPA is the basic national charter for the protection of the environment and establishes policies, sets goals, and provides means to carry out the policies. For certain types of federally funded or federally permitted transportation projects, NEPA will require the preparation of an environmental impact state-

ment. Moreover, certain types of transportation projects will require the determination of air quality conformity pursuant to CAAA (ensuring that the proposed project will not impede efforts to reduce air pollution in the metropolitan area).

For airport access projects, the responsibility for overseeing the environmental process may require the cooperation of FAA, FHWA, or FTA, or all three. The environmental process must be completed before federal funding can be used. In instances in which FHWA is the lead federal agency for NEPA compliance, it can delegate its NEPA responsibilities to the state.

AIRPORT–AIRLINE CONTRACTUAL AGREEMENTS

Although federal statutes, regulations, and policies allow airport operators to use airport revenues for certain ground access projects, some airport operators have entered into agreements with airlines that give the airlines the right to approve or disapprove the use of airport revenue for capital projects. The reasons for entering into airline agreements and the status of those agreements at certain major airports are discussed below.

Framework for Airline Agreements

Most airport operators have entered into agreements with the airlines serving their airports. Airport operators enter into airline agreements for a variety of reasons:

- **Capital investment programs.** Airport operators developing and financing major capital improvement programs typically prefer airline financial support and commitment to relocate in order to improve the airport's creditworthiness in the financial community. Improving airport creditworthiness is one of the primary historical motivations for airline agreements.
- **Airport hubbing and airline market share.** Operators of airports served by major hubbing airlines that have high market share generally favor airline agreements because of (1) the more airline-specific nature of facility design and use and (2) the greater reliance on that airline's payments to cover airport operating expenses and pay debt service on bonds. Airports that primarily serve origin and destination passengers and at which more airlines provide competitive service tend to be less dependent on airline agreements.
- **Market growth.** Airports whose air transportation markets exhibit strong growth tend to be less dependent on airline agreements than airports with flat or declining market growth.
- **Market type.** Airports that serve air transportation markets driven substantially by tourism or conference activ-

ities tend to be (1) more focused on business partnerships with all supporting service providers, including airlines; and (2) more interested in airline agreements.

- **Airline tenant stability.** Airports with a significant portion of traffic served by financially healthy airlines tend to be less dependent on airline agreements than airports whose primary air service is provided by financially troubled airlines.
- **Facility availability.** Airports with facilities that exceed current demand tend to be more dependent on airline agreements than airports with excess demand for facilities.
- **New entrant potential.** Airports that have potential new entrant airlines tend to avoid restrictive agreements that may limit the airports' abilities to accommodate new entrants.
- **Airport economics.** The more dependent an airport is on airline revenue as a percent of total revenue, the greater the need for a structured relationship with the airlines. Airports with relatively high levels of nonairline revenue (e.g., more than 60 percent of total revenue) and high levels of annual cash flow are less vulnerable to airline revenues.
- **Political environment.** The higher the actual or desired political involvement of local governments in the airport, the more airport operators tend to prefer airline agreements. The airline agreements insulate the airport against political micromanagement and minimize the airlines' ability to use political mechanisms to affect decisions regarding the airport.
- **Historical airline relations.** Airport operators who have a history of more reasonable or cooperative relations with airlines that serve the airport tend to support future agreements; those airport operators with more difficult historical relations tend to prefer not to enter into future airline agreements.
- **Federal policy.** FAA's *Policy Regarding Airport Rates and Charges* is not generally applicable to rates and charges established by agreement for those parties signatory to the agreement. An agreement provides insulation for the airport from complaints to FAA by signatory airlines. However, nonsignatory airlines may register complaints with FAA. Airport operators and airlines cannot agree to use airport revenue in a manner that violates FAA's policy concerning the use of such revenue.

Although most recent airline agreements have shorter 5- or 10-year terms, many airline agreements are long-term agreements lasting 20 or 30 years. Many of the factors that originally caused a particular airport operator to enter into an agreement may change during the term of the agreement. It is very difficult to terminate an agreement, however, because the very factors that may cause an airport operator to want to terminate the agreement may reinforce the signatory airlines'

desire to continue the agreement, so the signatory airlines are not likely to vote to approve termination.

Status of Airline Agreements

Table 7-3 presents an inventory of airline agreements at selected large- and medium-hub airports. The table indicates whether each airport has an airline agreement and the agreement's date of expiration, if applicable.

In all cases in which an airline agreement is in place, the airlines have some control over airport capital investment decision making. The airlines typically do not favor significant investment in transit projects or even in certain roadway projects; instead, the airlines prefer that available cash flow be invested in facilities the airlines use, such as terminal and airfield facilities, and prefer to keep debt service low to minimize their cost per enplaned passenger.

In some cases, an MII of the signatory airlines must affirmatively approve investment in capital projects funded with bonds whose debt service affects the airline rate base and in capital projects funded with nondiscretionary cash flow. This is the case at Chicago-O'Hare, Dallas/Fort Worth, Seattle-Tacoma, Miami, and Minneapolis-St. Paul International Airports and at Detroit Metropolitan (Wayne County) Airport. At San Francisco Airport, an affirmative MII vote is required, but a capital project can proceed without such approval after a 6-month deferral period.

In other cases, a capital project can proceed unless an MII of the signatory airlines disapproves the project, such as at Philadelphia Airport and the commercial service airports in Hawaii.

At airports that have airline agreements and at those that do not, the airport operator must support investment in a ground access project for it to proceed. Unlike the airlines, airport operators have a stake in reducing roadway and curb congestion by managing existing facilities and investing in roadway and transit projects. However, ground access projects compete with other airport capital projects for limited available funding and may not always be among the airport operator's priorities.

Examples of Airport Operator Support for Airport Transit Projects

Examples of specific projects in which airport operators have provided financial support for transit projects are discussed in the following paragraphs.

San Francisco International Airport

The San Francisco airport's project (known locally as "BART SFO") consists of construction of an extension of the

TABLE 7-3 Airline agreements at selected airports

Airport	Airline Agreement	Expiration Date
Boston-Logan International Airport	No	n.a.
Hartsfield Atlanta International Airport	No	n.a.
John Wayne Airport (Orange County, California)	No	n.a.
Los Angeles International Airport	No	n.a.
Phoenix Sky Harbor International Airport	No	n.a.
Miami International Airport	Yes	Month-to-month
Minneapolis-St. Paul International Airport	Yes	Month-to-month
Honolulu International Airport	Expired & extended	Quarterly
John F. Kennedy International Airport (a)	Yes	Quarterly
LaGuardia Airport (a)	Yes	Quarterly
Newark International Airport (a)	Yes	Quarterly
New Orleans International Airport	Yes	December 31, 2004
Portland International Airport (Oregon)	Yes	June 30, 2001
Seattle-Tacoma International Airport	Yes	December 31, 2001
San Diego International Airport (Lindbergh Field)	Yes	June 30, 2002
Chicago Midway Airport	Yes	December 31, 2002
McCarran International Airport (Las Vegas)	Yes	2003
Philadelphia International Airport	Yes	June 30, 2006
Orlando International Airport	Yes	October 2008
Detroit Metropolitan Wayne County Airport	Yes	January 1, 2009
Dallas/Fort Worth International Airport	Yes	September 30, 2009
San Francisco International Airport	Yes	June 30, 2011
Fort Lauderdale-Hollywood International Airport	Yes	September 30, 2011
Ronald Reagan Washington National Airport	Yes	September 30, 2014
Pittsburgh International Airport	Yes	May 8, 2018
O'Hare International Airport (Chicago)	Yes	May 11, 2018
Miami International Airport (b)	Yes	September 30, 2020
Denver International Airport	Yes	
United Airlines		February 28, 2025
Other airlines		2000 – 2005

NOTES: n.a. = Not applicable.

- (a) Mostly short-term leases, although some airlines have long-term leases. For example, Continental's long-term lease at Newark International Airport expires in 2018, and some leases at Terminal 4 at JFK International Air Terminal expire in 2018.
- (b) Agreement expires after completion of the "Program 70's," estimated to be September 30, 2020.

SOURCE: Transit Cooperative Research Program, Transportation Research Board.

BART system from the station at Colma to a new station in Millbrae, with a spur to the airport. A new consolidated station will be constructed at the airport to serve both the on-airport people mover (Airtrain) and the BART spur. The Airtrain is a closed-system people mover that will connect airport terminals, the consolidated rental car facility, and parking. The total cost of BART SFO, including the extension and stations but excluding Airtrain, is \$1.2 billion. The BART SFO project is expected to be completed in 2002. The city of San Francisco will contribute up to \$200 million to the project, of which \$113 million will be paid by the airlines through airport rates and charges to fund the on-airport station and guideway facilities. The city will contribute an additional \$87 million from other airport funds that are not in the airline rate base. The \$87 million will fund BART's on-airport oper-

ating systems, traction power, computers, and other equipment. FTA has committed \$750 million in capital New Starts funds for the BART SFO projects.

John F. Kennedy International Airport

The airport's light rail system, called Airtrain, will connect all of the airport terminals with Jamaica Station and the airport's network of rail, subway, and bus lines, as well as with the station at Howard Beach. The project is expected to reduce travel time to Manhattan by half an hour, compared with existing subway, bus, or private automobile travel times. Airtrain will also link the airport terminals with long-term parking and rental car areas. The total cost of this project is

estimated to be \$1.5 billion, and the project is expected to be completed by 2002. The Port Authority of New York and New Jersey will provide \$300 million for the project from its capital funds, and \$1.2 billion will be paid with PFC revenues.

Portland International Airport

The Portland airport's project (known locally as the "Airport MAX project") involves construction of an extension of the light rail system to the airport. The project consists of two major elements: (1) construction of a terminal segment track,

which will connect the airport with the existing 33-mi system; and (2) construction of the light rail station at the airport terminal. The \$141.3 million light rail program costs will be shared by the Port of Portland (\$43.0 million), the Cascade Station Development Company (\$3.2 million), the city of Portland (\$31.6 million), and Tri-Met (\$63.5 million) under the 1998 Framework and Rail Financing Agreement. The port is financing its \$43-million share from PFC bond proceeds and PFC pay-as-you-go revenue. The Port received a Record of Decision from FAA approving the use of PFC revenues for the project in June 1999. The project is expected to be completed in fall 2001.

CHAPTER 8

IMPLICATIONS FOR FURTHER RESEARCH

OVERVIEW

This report covers the first phase of the research program being undertaken for TCRP Project B-18, including work undertaken in 1999. Based on a decision by the TCRP Oversight and Project Selection (TOPS) Committee in October 1999, the program will be extended for a second phase. For this reason, this chapter will focus primarily on work contained in this report that impacts the formulation of a research scope for the second phase of TCRP Project B-18. The second phase, designated Project B-18A, is entitled “Improving Public Transportation Access to Large Airports: Phase II.” The results of the Phase II research will be published in the TCRP report series.

In the following sections, each chapter of the report is examined in terms of areas in which the originally planned work was completed, areas in which work was postponed, areas that require further analysis, and areas in which ongoing progress should be monitored to ensure that the final product for Project B-18A is accurate and up-to-date.

Implications of Chapter 1 for Further Research

Overview

Chapter 1, along with the Executive Summary, summarizes the research results for the first phase of the project (Project B-18). The outline of the report clearly reveals the redirection of emphasis taken by the project panel in June 1999. At this time, a chapter not initially contemplated in the Working Plan was added at the direction of the panel: the new chapter, Chapter 5, examines the characteristics of successful fixed guideway systems around the world and documents the attributes of successful services for the benefit of U.S. practitioners considering fixed guideway investment. As a result of this reallocation of project resources, the chapter originally proposed in the Working Plan that described improved management strategies for rubber-tired services was deferred to a later stage of the project.

Implications for Further Research

The examination of the management of innovative strategies for improving rubber-tired transportation services is a

key element in the overall research effort. Examples of issues to be examined in the analysis of rubber-tired services are as follows.

At the curb. What can be done to better manage for the consumer? What can the airport operator do to provide a higher priority for the high-occupancy user? What are the tools for better curb management, such as AVI? What are the principles for the allocation of scarce curb space? What are the best strategies to provide connecting mode information to the arriving passenger?

Beyond the curb. How can airport operators coordinate with regional HOV and high-occupancy toll (HOT) lanes programs and strategies? Why are there so few examples of HOV projects serving major airports? Lessons can be learned from Seattle and New York and New Jersey.

Managing the supply of services. How do airports use franchising options to improve service to the consumer? How did Sacramento and Los Angeles respond to the need for competition and the need to balance demand with supply for a specific service?

Potential for new institutional relationships. What is the experience of major U.S. airports in creating and encouraging new services where needed? What is the role of the airport operator in setting standards for taxis, limousines, and other transportation services? What are the regulatory constraints to new services? What happens when there is an overlap between the taxi industry and other providers? What are the problems in the initiation of new services?

Implications of Chapter 2 for Further Research

Overview

Chapter 2 examined the airport ground access patterns of 25 of the largest U.S. airports and described the key factors affecting airline-passenger use and airport-employee use of public transportation access modes. The factors were determined through (1) a review of service at U.S. and international airports with rail service and (2) surveys of U.S. airport operators. Two areas in which additional analysis seems required are the orientation to the CBD and the role of em-

ployees as a market for public transportation services. The proposed research concerning the geographic distribution of trips (including the CBD) is described below in the review of the implications of Chapter 3.

Implications for Further Research

The survey undertaken for this project asked each airport to report on the availability of data concerning the geographic distribution of trip ends and data concerning employee mode shares. The response to the survey revealed a lack of immediately available data in both of these important areas. The quality of data concerning employee access patterns may require a significant data-analysis effort. There is a clear need for further examination of the challenge of improving public mode share for employees. Such a research effort would have to do the following.

Define the problem. Where do the airport employees work? Are their jobs located near the passenger terminal complex or in multiple remote locations of the airport? Some employees working for airport-based companies may not work on the airport. Where do the employees live? Are they evenly dispersed around the metropolitan area or in clusters along corridors adjacent to the airport?

Review the adequacy of data. Airport-based surveys of employees represent the most desirable source of data. But, in some cases, the U.S. Census Journey to Work Data may be for use as a supplement that is appropriate for aggregate observation. In other cases, local MPOs may have trip tables that present the airport as a single employment zone.

Undertake the analysis. The proposed research effort, subject to the availability of appropriate data sources, would document existing distribution of origins and existing mode shares. The research should document present price conditions for employee transport options and should explore the impact of subsidized (or free) parking provided on the airport.

Examine alternative strategies for specialized employee services. Based on an understanding of the needs of employees, this element of the work program would define candidate strategies for specialized services. Issues of implementation would be documented, including an analysis of methods of cross subsidization among revenue sources.

Document the experience of U.S. airports with specialized employee services. A small set of examples of successful specialized services for employee transportation would be described and documented. Parallel programs in Europe, such as the FreeFlow Heathrow employee program, will be documented as relevant.

Implications of Chapter 3 for Further Research

Overview

Chapter 3 presented the reasons for a user-based market research basis for ground access planning. In this approach, a variety of services is crafted to serve a variety of market needs. One of the most important determinants of an airport's ground access market is the geographic distribution of the airline passengers and airport employees traveling to and from the airport. It is also important to know the classification of airline passengers by market segment because airports will differ in the proportional distribution of these market segments.

Implications for Further Research

Based on comments from members of the panel, the research team has concluded that the examination of the geographic implications of the airport trip ends needs further documentation. Although the work program described in this report was often able to differentiate between CBD and non-CBD travel patterns in the existing data, further examination of variations in the non-CBD trip ends is needed. Such a continuation of the market research element of the project would examine and document the following.

Airport trip-end densities associated with successful fixed-route and scheduled services. This task would document the trip-end density associated with successful traditional services, including both bus and rail. The quantified density of CBD trips would be documented, as well as the characteristics of services to higher-density suburban subcenters. Examples of non-CBD high-density destinations, including universities, hospitals, and military installations, would be reviewed in terms of their propensity to support fixed-route and scheduled services from major airports.

Airport trip-end densities associated with flexibly routed door-to-door services. The demographics of areas in which door-to-door services have succeeded in creating higher vehicle occupancy will be documented, including both the land-use characteristics and density of airport-oriented trips. The role of door-to-door services in high-density areas that are often in competition with fixed-route and scheduled services will be documented. The characteristics of residential pick-up services and the challenges of low vehicle occupancies in lower-density situations will be examined.

Airport trip-end densities associated with express modes. Areas characterized by low airport trip-end densities pose a particular challenge to U.S. ground access planners. From these areas, longer-distance modes usually do not operate door-to-door and rely on some form of collection service. This section would examine trends in longer-distance service

and would document strategies currently used by the private sector to respond to lower-density origins.

Implications of Chapter 4 for Further Research

Overview

Chapter 4 examined 14 successful systems through observations about four elements of the total service. The chapter reviewed the experience of the 14 successful airport access systems in terms of four key factors, which together influence this cumulative experience. The international experiences documented in Chapter 4 serve to underscore the idea that there is no monolithic market for public transportation that can be served by a single modal solution. There are a series of submarkets, each of which requires the creation of services designed to meet the needs of that market segment. From Tokyo Narita Airport, the user has a choice of at least six different price levels from three separate rail operations. At London's Heathrow Airport, high-priced express rail service has been added to the airport's successful low-priced multistop rail service. At Paris' Charles de Gaulle Airport, a new high-priced express rail service to downtown will soon be offered in addition to current inexpensive multistop rail service. Oslo Airport offers low-priced multistop service, high-priced express service, and long-distance national service, all from the same platforms. The exceptional overall mode share to public transportation from the Hong Kong International Airport was accomplished with a combination of high-priced express rail, low-priced multistop rail, and low-priced direct buses.

Implications for Further Research

The major conclusion from the examination of the most successful international systems serves to support the themes put forward above (concerning the implications of Chapter 3) that a successful strategy must provide a variety of services that are designed around the needs of identifiable submarkets. A major theme in the study of European systems is the role of national markets or markets beyond the metropolitan area in which the airport is located. Although in many European systems these markets are served by the existing national rail system, the problem of capturing the exurban or rural trip maker parallels directly the issue faced in the U.S. experience. It is anticipated that examples of the European experience of serving challenging markets outside of the immediate metropolitan area can be incorporated into the market research described above for Chapter 3.

Implications of Chapter 5 for Further Research

Overview

Chapter 5 examined the attributes achieved in the implementation of the successful system that can be of use to the

U.S. practitioner considering the development of systems with both rail and bus services. The chapter shows that the ability of the systems to carry the customer (and his or her baggage) from door-to-door as compared with the private-vehicle alternative determines the market response to the service offered. The quality of the line-haul segment (be it rail or bus) must be considered in combination with the difficulty of getting to that vehicle and from that vehicle. In rare examples from Oslo and Hong Kong, designers were able to design the airport, rail line, distribution services, and baggage strategies as one integrated system. The actual method by which these attributes can be achieved in the U.S. experience may be different from the strategies used in Europe and Asia.

Implications for Further Research

Chapter 5 reviewed a series of characteristics of the successful systems and identified strategies from around the world that deal with key design and operational issues. These issues, such as integrated facility designs and baggage-handling mechanisms, were summarized in the chapter. Because of the rapidly developing attention to these issues in the United States, design and operating strategies are now being developed at a significant rate. To complete the examination of design and operational strategies that support advanced airport access systems, the U.S. experience should be documented in the following areas.

Completed examples of integrated design at transfer facilities. Recent design and architectural experience at Washington, D.C.'s Reagan National and at San Francisco's airport should be documented, as well as examples of integrated facility design in airports such as Hartsfield Atlanta and Lambert-St. Louis.

Work in progress for intermodal transfer facilities. Design activity at airports in Newark, Miami, Seattle, New York (at JFK), and at other airports should be documented for inclusion in the examination of innovative strategies.

Examination of baggage-handling strategies. Recently implemented check-in facilities at Hartsfield Atlanta and those under consideration at Newark, JFK, and Miami Airports would be documented.

Baggage strategies for specialized bus service. The U.S. experience with baggage handling associated with specialized bus services, including those services operated by airlines and by the cruise industry, should be documented.

Institutional constraints. The challenges associated with FAA security regulations, liability and lost-baggage concerns, and integration of schedules (e.g., connect times) should be documented.

Update data on new systems in operation. Recent experiences from the first 2 years of operation of advanced systems should be documented for use by U.S. practitioners. Such a review could include examination of issues of cost, liability, and customer utilization.

Implications of Chapter 6 for Further Research

Overview

Chapter 6 examined certain advances in technology in the transit and aviation industries that may affect the future of airport ground access programs. The six areas in which the technology of the transit industry combines with that of the aviation industry to improve the quality of airport ground access were (1) ATIS, (2) technology for ride matching, (3) emerging bus technology, (4) emerging rail technology, (5) automated people-mover technology, and (6) alternative strategies for off-site airport check-in.

Implications for Further Research

Several of the technologies discussed in Chapter 6 are currently being advanced as part of both national and local policy commitments. Information systems that will offer ground transportation routes, schedules, and information are being developed and examined by such groups as the ATIS Committee of ITS America. These information systems should be monitored to ensure that the needs of airport ground access systems are considered in their development. The report for Phase II (Project B-18A) should provide updated descriptions of recent activities in such areas as the following.

Metropolitan passenger information programs. Ongoing progress in metropolitan initiatives, such as the intermodal passenger information system in the New York–New Jersey–Connecticut Model Development Initiative, should be documented.

Multistate initiatives for passenger information. The project should provide updated information on the role of national and multistate initiatives, such as the I-95 Corridor Coalition program to develop traveler information systems for providing local public transportation information to long-distance air and rail travelers.

Private-sector role in airport ground transportation information. The role of the private sector in providing information and ticketing for ground access modes, such as Ride-

source.com. and totheairport.com, should be included in the analysis.

International experience in intermodal passenger information. The implications of recent international experiences to provide multimodal traveler information for long-distance travelers, such as through the EU Spirit of the European Union, should be documented in the report.

Automating the check-in process. Progress in the implementation of programs that could potentially improve the off-site airport check-in process, such as the implementation of common-use terminal equipment (CUTE) technology and the use of microchip-based smart cards, should be documented.

Implications of Chapter 7 for Further Research

Overview

Chapter 7 examined a series of recent changes in funding sources available for airports and the administrative flexibility inherent in certain airport financial management structures to accommodate changes in priorities. The chapter provided an overview of the key legal, financial, institutional, and jurisdictional factors affecting public transportation to airports. Three major areas of institutional determinants to financing airport access projects were reviewed: (1) federal funding and oversight, specifically FAA policies related to the financial support of airport ground transportation projects; (2) funding of surface transportation projects by FHWA and FTA and by the states; and (3) contractual agreements between airport operators and airlines that limit the use of airport funds. The chapter documented how FAA's policies with regard to use of airport revenue have recently changed to allow greater flexibility in funding airport access projects.

Implications for Further Research

Over the past year, significant changes have been made in the flexibility of several funding sources and in the guidance provided by FAA. Local managers should become aware of the programs described in this chapter. Given the extent of change that has occurred, the current need may be to widen the understanding of the new regulations, rather than to conduct research into further regulatory change. The report on Phase II should present updated examples of how the new rules have been applied and include whatever updates and modifications may have taken place by the time of publication.

REFERENCES

1. Chicago Transit Authority, Planning Division. Orange Line Travel Survey, May 1994, and Midway Airport Ground Travel Survey, January 1995.
2. Metropolitan Atlanta Rapid Transit Authority. Station surveys.
3. Metropolitan Atlanta Rapid Transit Authority, Division of Planning and Policy Development. 1990 Rail Passenger Study, p. 14.
4. Chicago Transit Authority, Strategic Planning Department. O'Hare Airport Ground Travel Survey, June 1990.
5. Massachusetts Port Authority and the Central Transportation Planning Staff. 1997 Massport Survey, Boston.
6. Rickard, D. "Challenges in Developing an Airport Employee Commute Program: Case Study of Boston Logan International Airport." *Transportation Research Record 1506*, Transportation Research Board, National Research Council, Washington, D.C. (1995); pp. 70–81.
7. Charles River Associates. Logan International Airport Ground Access Study, 1987.
8. Cuyahoga County (Ohio). *Cleveland Hopkins Airport Access Study: Survey Results*, U.S. DOT, Washington, D.C. (1970); and "Ridership Trends, Cleveland Transit System." In Gosling, G., A. Kanafani, A. Bender, and V. Evmolpidis. *Off Airport Passenger Terminals*. UCB-ITS-RR-77-16. Institute of Transportation Studies, University of California, Berkeley (1977).
9. Wilson, Hewitt & Associates. Philadelphia International Airport Ground Transportation Passenger Survey, Interpretation of Survey Results, 1986.
10. Harvey, G. *Ground Access to San Francisco International Airport*. San Francisco Airports Commission, Berkeley, CA (1988).
11. Pacific Transit Management. Analysis of Ground Transportation at San Francisco International Airport, May 1999.
12. Personal communication from the management of Baltimore-Washington International Airport, 1997.
13. Massachusetts Port Authority. Internal documents and personal communication from M. Richardson, Massport Ground Operations Manager, 1997.
14. Massachusetts Port Authority. Internal documents based on the 1996 Logan Airport Ground Access Survey.
15. Charles River Associates, Logan International Airport Ground Access Study, 1987; Massachusetts Port Authority, internal documents; and M. A. Coogan.
16. Personal communication from D. Ricard, Cambridge Systematics, 1997.
17. Harvey, G. *Ground Access to San Francisco International Airport*. San Francisco Airports Commission, Berkeley, CA (1988). In 1988, a 23 percent mode share for Airporter use in Marin County in 1985 was reported.
18. Port Authority of New York and New Jersey. Airport Access Study, 1992, and Airport Access Study, New York, 1997.
19. *Access to Denver International Airport: A Detailed Look at Passenger and Employee Travel to Denver's New Airport in 1995 and 1996*. Denver Regional Council of Governments, Denver, CO (1997).
20. Sources for employee data:
 - O'Hare Airport: Based on an estimate of 4,800 employee boardings and 48,000 total workers.
 - Boston Logan Airport: Rickard, D. "Challenges in Developing an Airport Employee Commute Program: Case Study of Boston Logan International Airport." *Transportation Research Record 1506*, Transportation Research Board, National Research Council, Washington, D.C. (1995); pp. 70–81.
 - Newark, LaGuardia, and JFK Airports: Port Authority of New York and New Jersey. Surveys as cited in *Airport Access Planning Guide*. Phase I Draft, December 1995. Prepared for the Federal Highway Administration and the Federal Aviation Administration by BMI in association with Leigh Fisher and M. A. Coogan.
 - Denver Airport: *Access to Denver International Airport: A Detailed Look at Passenger and Employee Travel to Denver's New Airport in 1995 and 1996*. Denver Regional Council of Governments, Denver, CO (1997).
 - Schiphol, Cologne, Frankfurt, Hamburg, and Manchester Airports: Pearson, M., quoted in the International Air Rail Organisation Database. London: BAA Heathrow, Heathrow Airport Transportation Policy—Factfile. Internal document, 1997.
21. Examples of such projects include TCRP Project B-08, Effective Methods of Marketing Transit Services to Business (see also *TCRP Report 51*); TCRP Project B-09, Market Segmentation Strategies to Increase Transit Ridership (see also *TCRP Report 36*); and TCRP Project B-20, Enhancing the Visibility and Image of Transit (see also *TCRP Report 63*).
22. Blakenship, A. B., and G. E. Breen. *State of the Art of Market Research*. American Marketing Association, Chicago, IL (1996), p. 121.
23. Massachusetts Port Authority. 1996 Logan International Airport Air Passenger Survey, Appendix B: Survey Methodology, p. B-2-3.
24. Blakenship, A. B., and G. E. Breen. *State of the Art of Market Research*. American Marketing Association, Chicago, IL (1996), pp. 168–169.
25. A complete description of market segmentation as it applies to public transportation is provided in *TCRP Report 36*, "A Handbook: Using Market Segmentation to Increase Transit Ridership," Transportation Research Board, National Research Council, Washington, D.C. (1998). This handbook provides many useful examples of market segmentation for public transportation across the United States.
26. Elmore-Yalch, R. *TCRP Report 36*, "A Handbook: Using Market Segmentation to Increase Transit Ridership," Transportation Research Board, National Research Council, Washington, D.C. (1998), p. 66.

27. Elmore-Yalch, R. *TCRP Report 36*, "A Handbook: Using Market Segmentation to Increase Transit Ridership," Transportation Research Board, National Research Council, Washington, D.C. (1998), p. 74.
 28. Massachusetts Port Authority. Logan Airport Access Survey Report, April 1984. Survey revised January, 1985, p. 25.
 29. Massachusetts Port Authority. A Review of Logan Airport's Ground Transportation Alternatives—Report on Qualitative Research, Massport, October 1984, p. 2.
 30. Massachusetts Port Authority. A Review of Logan Airport's Ground Transportation Alternatives—Report on Qualitative Research, pp. 5–9.
 31. Massachusetts Port Authority. Final Report, Behavioral Research and Marketing Analysis for the Logan Airport Ground Access Study, Massport, January 1987, p. 23.
 32. Massachusetts Port Authority. Final Report, Behavioral Research and Marketing Analysis for the Logan Airport Ground Access Study, Massport, January 1987, p. 29.
 33. Massachusetts Port Authority for the Massachusetts Executive Office of Transportation & Construction. Feasibility Study: Expansion of the Logan Express Remote Bus System to Logan Airport, June 30, 1994, p. 18.
 34. Soo, E. "Determining Passenger Demands and Customer Service Requirements." Paper presented at the Air Rail East West Conference, Hong Kong, 1998.
 35. Pavaux, J. *Rail/Air Complimentarity in Europe: The Impact of High Speed Train Services*. Institute of Air Transport, Paris (1991).
 36. Bolland, S., P. Ndoj, and N. Ashford. *An Investigation of Ground Access Mode Choice for Departing Passengers*. Department of Transport Technology, Loughborough University of Technology, Loughborough, UK (1992).
 37. Bayman, R. "Positioning Commuter Rail Services to Serve Airports: Who Needs the Metro?" Paper presented at the Air Rail East West Conference, Hong Kong, 1998.
 38. Harding, B. "Heathrow Express—the First Three Months." Paper presented at the Air Rail 98 Conference, Frankfurt, Germany, 1998.
 39. Zurich Airport. *Untersuchung des Landseitigen Verkehrs, Herbst 1989*. Zurich, Switzerland.
 40. Civil Aviation Authority. CAP 677, Passengers at Birmingham, Gatwick, Heathrow, London City, Luton, Manchester, and Stanstead Airports in 1996. London, November 1997.
 41. International Air Rail Organisation. *Air Rail Express*. IARO, London, 1999.
 42. International Air Rail Organisation. *Air Rail Express*. IARO, London, 1999.
 43. Noble, R., and the Mass Transit Railway Corporation. "Hong Kong's Airport Express: Lessons from the First Two Months Operations," Paper presented at the Air Rail 98 Conference, Frankfurt, Germany, 1998.
 44. Noble, R., and the Mass Transit Railway Corporation. "Hong Kong's Airport Express: Lessons from the First Two Months Operations," Paper presented at the Air Rail 98 Conference, Frankfurt, Germany, 1998.
 45. Pavaux, J. *Rail/Air Complimentarity in Europe: The Impact of High Speed Train Services*. Institute of Air Transport, Paris (1991).
 46. *We Are Linking the Øresund Region Together: A Fixed Link to the Future: Trains and Buses in an Integrated Public Transport Network with a Single Tariff and Ticket System*. Danish State Railways, Statens Järnvägar, and Hovedstadens Trafikselkab, Copenhagen, 1997.
 47. *We Are Linking the Øresund Region Together: A Fixed Link to the Future: Trains and Buses in an Integrated Public Transport Network with a Single Tariff and Ticket System*. Danish State Railways, Statens Järnvägar, and Hovedstadens Trafikselkab, Copenhagen, 1997.
 48. Pavaux, J. *Rail/Air Complimentarity in Europe: The Impact of High Speed Train Services*. Institute of Air Transport, Paris (1991).
 49. Pavaux, J. *Rail/Air Complimentarity in Europe: The Impact of High Speed Train Services*. Institute of Air Transport, Paris (1991).
 50. Personal communication from G. Lee, Mass Transit Railway Corporation, Hong Kong, 1999.
 51. Scholch, M. "Intermodality at Frankfurt Airport." In *Proceedings of the Air/Rail Conference*, Frankfurt, Germany, 1998.
 52. Smart Trek website (www.smarttrek.org).
 53. Giuliano, G., R. Hall, and J. Golob. *Los Angeles Smart Traveler Field Operational Test Evaluation*. California PATH Research Report, UCB-ITS-PRR-95-41. University of Southern California, Berkeley (1995).
 54. Gosling, G., and S. Lau. *Evaluation of a California Demonstration of an Automated Airport Ground Transportation Information System*. Research Report UCB-ITS-RR-95-3. Institute of Transportation Studies, University of California, Berkeley (1995).
 55. Crain & Associates and Multisystems for the National Transit Institute. "Reinventing Transit Using Information Technology." Seminar at Rutgers, the State University of New Jersey, 1998.
 56. Crain & Associates and Multisystems for the National Transit Institute. "Reinventing Transit Using Information Technology." Seminar at Rutgers, the State University of New Jersey, 1998.
 57. Crain & Associates and Multisystems for the National Transit Institute. "Reinventing Transit Using Information Technology." Seminar at Rutgers, the State University of New Jersey, 1998.
 58. Personal communication from PLANit, Sweden, AB. Interviews undertaken in Gothenburg, Sweden, 1998.
 59. Volpe National Transportation Systems Center. *Bus Rapid Transit Demonstration Program*. Federal Transit Administration, Washington, D.C. (1998).
 60. Port Authority of Allegheny County in association with Pennsylvania Department of Transportation. *Phase 1 Airport Busway/Wabash HOV Facility in Allegheny County, Pennsylvania: Final Environmental Impact Statement*. Federal Transit Administration, Washington, D.C. (1994).
 61. Airports Council International-North America. 1997 General Survey.
 62. Federal Aviation Administration. *Policy Regarding Airport Rates and Charges*. Vol. 61, No. 121. U.S. Department of Transportation, Washington, D.C. (1996).
-

GLOSSARY

ABBREVIATIONS AND ACRONYMS

AAIA	Airport and Airway Improvement Act of 1982	IARO	International Air Rail Organisation
ADA	Americans with Disabilities Act	IATA	International Air Transport Association
AIP	Airport Improvement Program	ICE	InterCity Express (Frankfurt)
APTA	American Public Transportation Association	ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ATIS	Advanced Traveler Information System	ITS	intelligent transportation systems
AVI	automated vehicle identification	LAWA	Los Angeles World Airports
BAA	British Airports Authority (formerly)	maglev	magnetic levitation
BART	Bay Area Rapid Transit (San Francisco)	MARC	Maryland Rail Commuter service
BTS	Bureau of Transportation Statistics	MARTA	Metropolitan Atlanta Rapid Transit Authority
CAAA	Clean Air Act Amendments of 1990	Massport	Massachusetts Port Authority
Caltrans	California Department of Transportation	MBTA	Massachusetts Bay Transportation Authority
CBD	central business district	MDI	Model Deployment Initiative
CMAQ	Congestion Mitigation and Air Quality Improvement Program	MII	Majority-in-Interest provision
CRS	computer reservation system	MPO	metropolitan planning organization
CTA	Chicago Transit Authority	MTRC	Mass Transit Railway Corporation (Hong Kong)
CTPS	Central Transportation Planning Staff (Chicago CTA)	MVV	Munich Transport Alliance
currency	DKr Danish kroner	NEPA	National Environmental Policy Act
	DM German deutschemark	NHS	National Highway System
	F French franc	NTSB	National Transportation Safety Board
	Fr Swiss franc	OAG	Official Airline Guide
	FR Belgian franc	OSHA	Occupational Safety and Health Administration
	G Dutch guilder	OVR	the Netherland's transit itinerary trip planning system
	HK \$ Hong Kong dollar	PFC	passenger facility charge
	£ British pound	PTRC	Planning and Transport Research and Computation International Association
	Nkr Norwegian kroner	RATP	Paris' local public transit operator
	Skr Swedish krona	RER	electrified suburban rail network (Paris)
	US \$ United States dollar	RTD	Regional Transportation District (Denver)
	¥ Japanese yen	SAMPO	System for Advanced Public Transport Operations
CUTE	common-use terminal equipment	SAS	Scandinavian Airlines System
Deutsche Bahn	German Federal Railroad	SCAG	Southern California Association of Governments
DOT	department of transportation	SIB	State Infrastructure Bank
EPA	Environmental Protection Agency	SNCF	French National Railways
ERL	Express Rail Link (Kuala Lumpur)	STIP	State Transportation Improvement Program
FAA	Federal Aviation Administration	STP	Surface Transportation Program
FEIS	final environmental impact statement	TCRP	Transit Cooperative Research Program (TRB)
FHWA	Federal Highway Administration	TEA-21	Transportation Equity Act for the 21st Century
FTA	Federal Transit Administration	TIFIA	Transportation Infrastructure Finance and Innovation Act
GARBs	general airport revenue bonds	TIP	Transportation Improvement Program
GDS	global distribution system	TOPS	TCRP Oversight and Project Selection (TRB committee)
GPS	global positioning system	TRB	Transportation Research Board
HOT	high-occupancy toll		
HOV	high-occupancy vehicle		

Tri-Met Tri-County Metropolitan Transportation District of Oregon
U.S.DOT United States Department of Transportation
WMATA Washington Metropolitan Area Transit Authority

AIRPORTS CITED

Asia and the Pacific Rim

Hong Kong

Hong Kong International Airport

Japan

Kansai International Airport, Osaka
 New Tokyo International Airport Narita (Tokyo Narita)
 Tokyo International Airport Haneda

Malaysia

Kuala Lumpur International Airport

Europe

Belgium

Brussels International Airport

Denmark

Copenhagen Airport

France

Charles de Gaulle Airport, Paris
 Paris Orly Airport (Orly)

Germany

Berlin Bradenburg International Airport
 Düsseldorf International Airport
 Frankfurt International Airport
 Hamburg Airport
 Cologne/Bonn International Airport, Cologne
 Leipzig/Halle Airport
 Munich Franz Josef Strauss Airport (Munich)
 Schonefeld Airport, Berlin

Italy

Malpensa Airport (Milan)

the Netherlands

Schiphol Airport, Amsterdam

Norway

Oslo Airport, Gardermoen

Sweden

Arlanda Airport, Stockholm

Switzerland

Geneva International Airport, Cointrin
 Zurich Airport

United Kingdom

Heathrow Airport, London
 London Gatwick Airport (Gatwick)
 London Luton Airport (Luton)
 London Stansted Airport (Stansted)
 Manchester Airport

United States and U.S. Territories

Arizona

Phoenix Sky Harbor International Airport

California

Burbank-Glendale-Pasadena Airport
 John Wayne Airport, Orange County
 Los Angeles International Airport
 Metropolitan Oakland International Airport (Oakland)
 Sacramento International Airport
 San Diego International Airport
 San Francisco International Airport
 San Jose International Airport

Colorado

Denver International Airport

Florida

Ft. Lauderdale-Hollywood International Airport
 Miami International Airport
 Orlando International Airport
 Tampa International Airport

Georgia

William B. Hartsfield Atlanta International Airport
 (Hartsfield Atlanta)

Hawaii

Honolulu International Airport

Illinois

Chicago Midway Airport (Midway)
 Chicago-O'Hare International Airport (O'Hare)

Indiana

Indianapolis International Airport

Louisiana

New Orleans International Airport

Maryland

Baltimore-Washington International Airport

Massachusetts

Boston General Edward Lawrence Logan International Airport (Boston-Logan)

Michigan

Detroit Metropolitan (Wayne County) Airport, Detroit

Minnesota

Minneapolis-St. Paul International Airport

Missouri

Lambert-St. Louis International Airport

Nevada

Las Vegas McCarran International Airport

New Jersey

Newark International Airport

New York

John F. Kennedy International Airport, New York City (JFK)

New York LaGuardia Airport, New York City (LaGuardia)

North Carolina

Raleigh-Durham International Airport

Ohio

Cleveland Hopkins International Airport

Oregon

Portland International Airport

Pennsylvania

Lehigh Valley International Airport, Allentown

Philadelphia International Airport

Pittsburgh International Airport

Puerto Rico

Luis Munoz Marin International Airport, San Juan

Texas

Bush Intercontinental Airport/Houston

Dallas/Fort Worth International Airport (Dallas/Fort Worth)

Dallas Love Field

Utah

Salt Lake City International Airport

Washington

Seattle-Tacoma International Airport

Washington, D.C.

Ronald Reagan Washington National Airport

(Reagan National)

Washington Dulles International Airport (Dulles)
