# ROUTE LAYOUT PHILOSOPHY AND SERVICE COORDINATION PARTICULARLY FOR LIGHT RAIL TRANSIT

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Peak-period and all-day service in public transportation are discussed with emphasis on light rail transit. Peak-period service treats each line as a separate entity operating from residential neighborhoods directly to the central business district. This type of service is typified by the American metro-mode motor-bus concept. Each route in an all-day service interacts with every other route enabling regionwide mobility. This integrated approach is found throughout Europe and is also well developed in a few U.S. and Canadian cities. Traditional network arrangements, such as radial and grid setups, and more recent concepts, such as the timed transfer focal point, are considered. Detailed aspects of service integration including schedules, passenger facilities, information, and fares are reviewed. That a widespread disinclination in North America to implement integrated systems exists because of limited funds and management disinterest is noted. The organizational structure successfully adopted in Europe to bring about service integration is described.

In North America today, 2 different schools of thought exist concerning the layout and function of a transit system in a metropolitan area. One approach, the single-line approach, perceives the ideal transit system as a set of individual, unrelated routes covering an urban area with each route offering the user direct, no-transfer service between some point of origin to 1 or more on-line destinations, which, in most cases, involves the central business district (CBD). Although this approach can be applied to any mode, recently it has been widely featured as a central element in a commercial scheme using motor buses (metro mode).

The alternative to treating routes separately is to view each as part of an overall system with interaction between them taking place at numerous transfer points. In this network approach, 1 or more modes are knit together into a unified whole, which permits the user to travel to a wide variety of destinations throughout the urban area in exchange for the minimum (if the design is correct) inconvenience of a transfer.

This paper discusses these 2 approaches as applied to metropolitan transit, particularly light rail transit, and describes aspects of coordination that are either common to any coordinated system or are peculiar to light rail transit.

## ROUTING AND SERVICE PHILOSOPHY

### Single-Line Approach

Transferring has been identified in a number of consumer preference surveys as a factor that is strongly disliked by many users. Frequently mentioned complaints include long wait times between transit vehicles, unreliability of connections, and poor or nonexistent station facilities. These unsatisfactory experiences have led to this negative consumer attitude. The response of some transit systems has been to design services that do not require a physical transfer. In the minds of planners of these systems, and in the way the systems are operated, there is no interaction of transit lines. Each is a unique element; there are no feeder routes, no crosstown connecting routes, and there is no mode-to-mode transfer.

Although it is an advantage for the consumer to avoid the various discomforts of transferring and although a no-transfer system is easier to operate, the single-route, no-transfer approach has a serious drawback in that there are very few origin-destination pairs in metropolitan areas that warrant their own direct linkage. Typically, only those links between a residential area and the CBD can be justified. As a consequence, many important lines are not served by transit services, which leads to a high level of dissatisfaction on the part of those whose intended journey is to some place other than downtown. From the standpoint of transit system revenues, this approach typically leads to rather high peak-to-base ratios and low ridership outside the peak hour. Exceptions to the latter occur on routes that serve important corridors that have a variety of origins and destinations of all kinds along them. Many central city lines and development strips in the older streetcar suburbs are of this nature.

If the objective of the transit system is seen solely or primarily as carrying rush-hour commuters to downtown office buildings, this design concept can be appropriate. It is easy to implement and simple to run. Buses are routed through residential neighborhoods and then head for the nearest freeway, arterial street, or exclusive busway for a nonstop trip to the CBD. There are no connections to make, no short turns to make, no stations to build, no fare systems to coordinate, and no inspectors on the street to ensure reliability. In fact, there is no integration to worry about because the essence of this approach is the independence of each line. Numerous examples of this kind of route design can be found in U.S. cities and particularly in suburbs.

Less common, but equally workable where passenger volumes warrant the necessary capital expenditure, is the operation of light rail vehicles on local streets where routes converge and trunk into the downtown on a high-speed light rapid transit corridor. San Francisco provides the most commonly referred to case, but Boston, Philadelphia, and Pittsburgh also feature this design element. The reader should note that, for these light rail cases, some passengers transfer from nearby bus routes, which makes these examples somewhat less than pure. Indeed, the transfer and the wide range of travel possibilities that it offers are central to the network approach.

## Network Approach

The alternative to thinking of transit services as individual lines is to think of them as a network. In the network a passenger can travel anywhere in the metropolitan area by means of transfers between lines. On a system designed this way, important origin-destination pairs will have high-quality service, but desired trips that are not possible with the single-line approach can be accommodated by piecing together sections of routes with a transfer. This systems approach means that the user is offered a wide variety of destinations. In gestalt fashion, it also means that the transit system receives a level of ridership on its route that is greater than if these same routes were operating independently (1).

As might be expected, there is a relationship between transit ridership and the degree to which the transit system adopts a network approach. As a public transport system develops, the orientation of its network passes through several stages (20). The simplest stage in this hierarchy of transit services offers a system that provides service only to the CBD, generally only during the rush hours. The second level includes systems that still basically display a radial, CBD-oriented pattern but offer frequent service at all hours of the day. The third, or highest level, exhibits a grid pattern, in which routes not only provide good access to downtown but also cut across radials to link one suburban area to another. Each of these 3 levels is shown in Figure 1. Generally speaking, 25 or fewer annual rides per person are associated with level 1; 50 or more annual rides per person are associated with level 3.

## Grid Layout Approach

Instituting a route pattern that will allow for a high degree of mobility about an urban area is possible. If one organizes one's routes into a citywide grid with 0.5-mile (0.8-km) spacing, which means that no user has more than a 0.25-mile (0.4-km) walk to the nearest route, a person can travel from any place to any other place on no more than 1 transfer. If the frequency of the services operated on the grid is high, say, between 5 and 10 min, waiting time at the transfer point is minimal. To produce such a grid system for an entire metropolitan area (city and suburbs) would consume a considerable amount of resources. Financial losses would be particularly high in the suburban areas where the density of development, and consequently the trip generation, is rather low. As a result, grids are usually found within the central city. Nevertheless, in these situations, the level of transit ridership is high, and the transit operation functions as an integrated system, regardless of the particular mode used on an individual route.

The best example of an integrated grid in North America is that operated by the Toronto Transit System in Canada. There, both city and suburbs are covered by a grid in which even the outer reaches of the built-up area have 20-min headways. The routes in this grid include conventional rapid transit, light rail transit, trolleybus, and motor-bus lines (3). So carefully is the integration worked out that 96 out of 109 surface bus and light rail lines make 131 connections with the 2 grid lines operated by heavy rapid transit (4). Transfers from bus to bus, bus to light rail transit, bus to heavy rapid transit, and light rail transit to heavy rapid transit are expedited by careful station design that minimizes confusion and walking time and at the same time offers pleasant surroundings.

Grid route layouts are usually found only in central cities in North America. In a recent scheme for the well-developed suburb of Berkeley, California, a grid system of surface routes was proposed. Most of the system would be bus routes except for the heaviest route, which would be a new streetcar line (5).

## Timed-Transfer, Focal-Point Approach

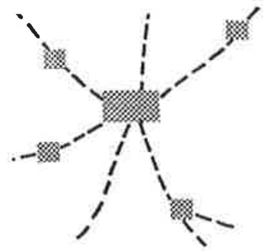
A grid system of transit routes will work well in the city, but only in exceptional cases (such as Toronto) can it function satisfactorily in low-density suburbs. Planners who have attempted to add simple crosstown routes to a radial system to provide a metropolitan-area-wide grid have had difficulty arranging connections between the low-frequency crosstown route and the many radial routes that it intercepts. As a consequence, waiting times are long and happy customers are few. The solution to this problem is to reduce the number of interception points so that connections become feasible. By establishing a limited number of nodes or focal points at which all routes serving that portion of the urban area can meet and by careful control of route length, one can arrange schedules so that all services arrive at 1 of these nodes or focal points at the same time (6).

This timed connection at a focal point on the network of transit routes enables a person to make a journey to any place in the urbanized area without long waits while transferring. The overall attractiveness of the service can be further enhanced if the focal points in the transit network coincide with the focal points of activity for the community in which it operates. In this way, transit routes that are put in place to provide regionwide mobility can also be used by local residents to make short trips to the closest supermarkets, department stores, or recreation centers. The resulting network of routes generally resembles that of a cobweb, as shown in level 3 of Figure 1.

**Figure 1. Three-part transit network hierarchy (20).**

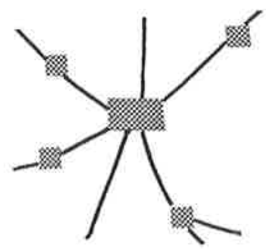
LEVEL ONE

Good rush hour service to Central Business District



LEVEL TWO

Good service to Central Business District at all times



LEVEL THREE

Good service throughout metropolitan region

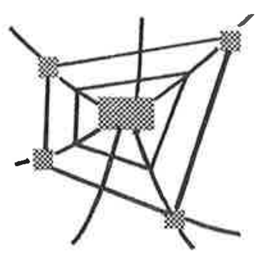


**Table 1. Types of transfer point stations in use with metropolitan railways (12, p. 31).**

| Metropolitan Area | Total Stations | Stations Connecting With Surface Routes | Type A Points | Type B Points: Existing | Type B Points: Proposed | Type B Points: Avg Number of Surface Routes Serving Each Point | Type C Points: Existing | Type C Points: Proposed | Type C Points: Avg Number of Surface Routes Serving Each Point |
|---|---|---|---|---|---|---|---|---|---|
| Barcelona, Spain | 46 | —[a] | —[a] | — | — | — | — | — | — |
| West Berlin, FRG[b] | —[a] | —[a] | —[a] | — | — | — | 8 | 1 | —[a] |
| Budapest, Hungary | 7 | 7 | 1 | 5 | 3 | 15 | 1 | 1 | 21 |
| Glasgow, Scotland | 11 | 11 | — | 11 | — | —[a] | — | — | — |
| Hamburg, FRG[b] | 75 | 46 | 34 | 4 | — | 3 | 8 | — | 7 |
| Copenhagen, Denmark | 24 | 21 | 5 | 15 | 3 | 3 | 1 | — | 3 |
| Lisbon, Portugal | 20 | 11 | — | 9[c] | — | — | 2 | — | 2 |
| London, England | 276 | 268 | 126 | 130 | — | —[a] | 12 | — | 10 |
| Milan, Italy | 43 | 32 | 25 | 7 | — | —[a] | — | 2 | — |
| New York (LIRR), N.Y., USA | —[a] | —[a] | —[a] | 17 | — | —[a] | 2 | — | 9 |
| Nuremberg, FRG[b] | —[a] | —[a] | —[a] | 1 | 1 | 4 | 1 | 1 | 1 |
| Paris, France | 309 | 254 | 133 | 98 | — | 6 | 23 | — | 9 |
| Philadelphia (PATCO), Pa., USA | —[a] | —[a] | —[a] | — | — | — | 2 | — | 7 |
| Rome, Italy | —[a] | —[a] | 9 | — | — | — | 2 | — | 1 |
| Rotterdam, Netherlands | 8 | —[a] | —[a] | 1 | — | —[a] | 1 | 1 | 39 |
| San Francisco, Calif., USA | 34 | 34 | 11 | 23 | 4 | 8 | — | — | — |
| Sydney, Australia | 157 | 69 | 54 | 15 | — | 5 | — | — | — |
| Stockholm, Sweden | 76 | 76 | — | 74[c] | — | —[a] | 2 | — | 6 |
| Stuttgart, FRG[b] | —[a] | —[a] | —[a] | 4 | — | 5 | — | — | — |
| Vienna, Austria | 27 | 21 | 18 | 1 | — | 4 | 2 | — | 6 |

[a]Not available. [b]Federal Republic of Germany (West Germany). [c]Figure includes type A points.

Edmonton was the first city in Canada to introduce the timed-transfer, focal-point concept (7, 8). Routes serving residential suburbs in this metropolitan area of 450,000 people focus on a local shopping center or other activity node. From there, radial routes proceed to the CBD, and cross-radial routes proceed to 17 other nodes. The heaviest trunk routes have frequent trolleybus and express bus service during local work hours. As passenger volumes build up on these corridors, the present service on the links will be replaced by light rail transit. This is now happening on the northeast corridor from downtown Edmonton, where a subway and surface light rail line is under construction and will be operational by 1977.

The results of this approach to transit service design have been most rewarding. At a time when many other transit systems were experiencing patronage decline, or, at best, were maintaining the status quo, the Edmonton Transit System was consistently posting a 5 or 6 percent annual growth rate to keep pace with and sometimes surpass the total population growth rate in the urbanized area. The 1962 patronage level of 26 million grew to 44 million in 1974. During the same time period, the Calgary Transit System, which uses a traditional routing structure (including nonstop express service to downtown), grew from 26 million to 28 million annual riders.

The timed-transfer, focal-point approach also has been used in British Columbia (9). This form of network design is being implemented in both the Greater Vancouver and Greater Victoria areas, and, as with Edmonton, higher quality forms of transit are to be substituted for buses on important links as patronage on these links grows. Thus a rapid transit ferry is being constructed between Vancouver and North Vancouver to replace an important express bus link; a suburban commuter rail service between Vancouver and the Coquitlam area is planned to provide rush-hour relief to the express bus service between eastern Burrard Peninsula points and Vancouver; and light rail routes are planned in both Vancouver and in Victoria for operation as soon as bus volumes become too high to be practical. The resulting system in Greater Vancouver will be an interconnected, interregional-level network. The links of the network will have a mix of rapid transit ferry, commuter rail, light rail, and express bus, all of which will be fed by local bus routes.

## COORDINATION

The purpose of coordination of services is to enable the public, by means of connections, to travel between 2 points that lack sufficient interaction potential to justify their own no-change, direct link. Because transferring involves some inconvenience, the transit manager should try to make the journey as close as possible to a no-change trip.

### Schedules

#### Frequent Service

The connection problem is simple when transfer movements involve only frequent lines. Buses, trains, and other modes arrive and leave at random, but, because the average wait time is short, timed (guaranteed) connections on the operating schedule of each vehicle are unnecessary.

Untimed connections with close headways are the most common form of schedule coordination with light rail in North America today and are widely found in Europe also. They are found with all physical modes. In North America, random connections from light rail to full rapid transit are found in San Francisco, Chicago, Philadelphia, Boston, Cleveland, Toronto, and Mexico City. Random connections from light rail to commuter rail (regional rail or S-bahn) links are found in Philadelphia, Boston, Newark, and Toronto. Random, frequent connections from light rail to trolleybus links are found in San Francisco, Toronto, and Mexico City. Random, frequent connections from light rail to motor bus are found everywhere.

### Infrequent Service

Convenient connections between busy routes may be easy to accomplish, but convenient connections between infrequently serviced routes not only are difficult but also are rarely found in North America. Anyone who has traveled often on transit services has experienced the feeling of dismay and frustration that comes when a connecting service pulls away just as the vehicle he or she is on pulls up. To this annoyance, add the passenger environment that is all too typical of even good systems (no shelter, poor lighting, minimal security, no information about alternatives), and it is little wonder that the act of transferring is given a negative rating on consumer surveys.

The obvious answer to the problem is to schedule connections and to enforce adherence to them. What is not so obvious is the host of operating difficulties that this poses to the average North American transit company, which finds it enough of a challenge to merely get its vehicles out each morning. These difficulties include accurate timekeeping (which, in turn, demands good supervision), proper timetable building, and freedom from random delays en route caused by traffic (12). Timed connections also usually include a requirement for regular-interval scheduling (clock headways) at least where the services run more often than 3 or 4 times per day.

There are no examples of connections between long-headway light rail and other services except late at night, when normally frequent LRT lines are cut back. There are, however, numerous examples of an important variant—connections from infrequent to frequent lines.

### Infrequent-to-Frequent Service

In those cases in which a frequent light rail line connects with an infrequent bus or other service, standard practice is to operate with random connections. Although this is easy on the carrier, it is hard on the user transferring from a frequent to an infrequent service. Fortunately, this difficulty is not experienced in the opposite situation because average waiting times are minimal. Because of longer waiting times in the frequent-to-infrequent direction, it is not too difficult for the transit company to select a connection and to guarantee it.

## Passenger Facilities

Proper attention to passenger facilities is essential to the successful operation of an integrated system.

### Types of Stations and Functional Considerations

A striking difference between the public transport systems in western Europe and those in North America is the attention paid by the former to facilities for passengers. In the United States and Canada, the patron usually finds either no facility or one that is old and has minimal facilities and maintenance. Passengers transferring between routes or modes in established downtown areas often find that the terminal point for suburban bus routes is not at the same point as the terminal point or major transfer point for urban routes and that neither of these bears any relationship to numerous rail and intercity-rural bus stations. In newer suburbs, the lucky passenger may find a simple glass or wood shelter; the not-so-lucky passenger has nothing more than a street corner and a sign. There are, however, exceptions to this rule. New rapid transit lines and a certain number of bus services have attractive station facilities. Light rail lines in Philadelphia, Boston, and San Francisco are renovating their old stations. And, in a number of cities in the United States and Canada, intercity railway passenger stations are being redeveloped as joint urban transit-intercity railway stations (10, 11).

Passenger facilities can be anything from a shelter or island platform in the street to a major rapid transit or intercity terminal. Some experimentation has been done with the development of passenger facilities that are a compromise between a simple shelter and a full station. These ministations can be found on Ontario's GO Transit commuter bus lines and at the terminus of the San Francisco Hyde Street cable-car line. With a ministation, a transit system may use an off-street platform area for buses and pedestrians, or it may use the street and sidewalk.

Cirenei (12) has identified 3 types of transfer stations in his analysis of integration of metropolitan railway services with other services.

1. Type A has interchange points with no special facilities.
2. Type B has interchange points with shelters or other simple structures to facilitate passenger waiting.
3. Type C has interchange points with integrated infrastructures designed to facilitate transfer between metropolitan railway lines and other modes of transport.

Data on twenty such systems are given in Table 1. As can be seen, nearly half the transfer points, even with full rapid transit, have minimal facilities. Note too that most places that have type B stations also have some of the more advanced type C facilities. Cirenei (12) points out:

> When surface transport is restructured and the different modes of transport allotted specialised functions, so that large numbers of passengers change at particular transfer points, it becomes necessary to equip these points with a minimum of protection (type B points) and at the same time to provide more complex facilities (type C points) where the volume of transferring passenger movements is greatest.

Careful attention to both vehicle flows and pedestrian flows is essential if a station is to work safely and smoothly. Although this does not necessarily mean that pedestrian flows and vehicle flows must be grade separated, it does mean that the pedestrian environment must be considered carefully and that long devious walks, a feature of even some of the newer stations, are avoided. One common failing of North American design that is evident in stations built by 1 carrier for the use of many carriers is that pedestrian flow between the various modes and the various carriers is not well worked out. Put differently, the station designers were thinking of their own management needs and generally have executed these properly but were not motivated to give the same level of consideration to users of other carriers at the same station. This kind of problem is less likely to occur where an independent agency or terminal authority is responsible for a station design (13, 14).

Because light rail transit is essentially a child of heavy rapid transit and the streetcar (much as the trolleybus is related to the streetcar and the motor bus), designers of stations have considerable flexibility in how they handle light rail transit. (For example, light rail cars can operate into the same stations, often by using the same tracks as commuter trains or heavy rapid transit.) An example of the former is contained in the Toronto Technical Transportation Plan Review proposals for an urban light rail system to share tracks with GO Transit commuter trains. An example of the latter can be found in Chicago where the North Shore Interurban (and its successor, the Skokie Swift) shares facilities with Chicago Transit Authority Rapid Transit. In Cleveland, the Shaker Heights Rapid Transit shares facilities and track with commuter rail and the heavy rail of the Cleveland Transit System.

The street running capabilities of LRT also enable it to be treated in the same fashion as buses at an interchange station. The simplest example of this is the familiar loop and shelter at which streetcars and buses exchange passengers. Other examples exist that are somewhat more sophisticated; at many of the exchange points for light rail and bus to heavy rapid transit in Toronto, bus and streetcars share common facilities or are treated similarly; at the Sixty-ninth Street station in Philadelphia, the Media and Sharon Hill light rail lines operate into and out of a facility also used by buses. In the latter case, a high-speed light rail line also terminates at the same place but receives a treatment more like that of a heavy rapid transit service (15, 16).

## Site and Setting Considerations

The preferred location for a transit station, whether it is a full-fledged facility or a ministation, depends on the nature of the service offered. Park-and-ride stations, for example, are best located away from built-up urban areas where land is cheaper and where the flow of automobiles does not congest developed areas. On the other hand, stations at which access is to be made by local transit routes should be located at activity centers or planned activity centers in the communities they serve. This arrangement has 3 benefits: (a) many passengers on the trunk service will find that their destination is within walking distance of the transit line; (b) passengers wishing to make a journey from a local residential area near the community activity center can do so by using a local bus; and (c) the tremendous impact that a transit station can have on development can be channeled by land use planners to serve the community's best overall interest.

## Giving the Transfer a Purpose

Imagine an automobile commuter wishing to pick up some groceries or other convenience goods on the way home from work. He or she must get into the car, drive to the desired store, leave the car, make the purchase, return to the car, and then drive to a final destination. He or she has broken a journey to accomplish some task in addition to simply getting home. If the transit authority encourages the development of small shopping centers at major stations or locates stations at shopping areas, then the passenger who has to transfer from one mode to another or from one service to another can buy groceries or other convenience goods while in the act of transferring. Thus the transfer has been given some additional purpose, other than being part of the journey home.

This kind of treatment has reached its zenith in Toronto, where a number of stations, such as Islington and Warden, contain a small shopping mall as an integral part of the station facility. Customers of the mall are in a fare-paid area and, as a result, shopkeepers receive 100 percent of their custom from transit users. The physical possibility already exists at or near some stations for passengers to disembark, shop, and board the next transit vehicle, but the fare system may prevent them from doing so. A relaxation of transfer conditions, such as those found with stop-and-shop provisions, is necessary to allow this to take place.

## Information

Visitors to Switzerland can purchase a pocket book that lists schedules and other details for every public transport service (except frequent central city lines) operating in that country. This enables them to plan and make a trip and use any number of modes and carriers. A visitor to Hamburg, Munich, or Frankfurt can obtain a large timetable book showing all services within the region served by the transit community. This book, which is about the size of a small telephone directory, is kept in the home and is used like a telephone book. When someone wants to make an other than usual journey, he or she merely looks up the information in the transit book. What a different situation in North America! In some cities, one can obtain a map showing services of 1 carrier. In Boston and San Francisco, one can obtain a map showing the lines of all carriers serving the area. Only in very small cities where there are only a handful of routes is an all-service timetable generally made available.

If an integrated system is to function properly, it is necessary for the user to have quick and easy access to the information necessary to complete the journey. This kind of information can be conveyed in the form of timetables, maps, or telephone information services. With the renewed interest in public transport, some very encouraging experiments are being tried with information conveyance. But, again, it is necessary for the people designing these information aids to be responsive to the needs of patrons wishing to make multiroute or multicarrier journeys.

## Simplicity

Children are taught in school how to use traffic lights and public libraries. In some high schools, they are taught how to drive. Rare, however, is the school that teaches its students how to use a timetable. The transit manager of today is confronted with a consuming public to whom even the easiest of timetables or other information can be a mystery. With this unfortunate state of affairs, a key element in information dissemination is simplicity, and one of the most basic aids to simplicity is a simple system design. A simple, logical route layout permits easy comprehension and may generate more patronage than might a complicated one that has better performance on another service variable. This rule is particularly important for managers and planners of integrated systems to follow because connections in and of themselves are complicated.

## Fares

### Price

Integrated service implies an integrated pricing system. Whether a zone fare or a flat fare is adopted, the passenger on a journey involving a transfer between routes or between carriers should not be penalized financially. Most systems offer free transfers between routes of the same carrier. A few, such as the Greater Vancouver Transit System, make them available between carriers.

### Fare Collection System

The standard method of fare collection and fare checking in North America is a 1-person-operated collection in which a driver collects the revenue and, if necessary, issues and checks zone coupons. In rapid transit systems, fares are almost uniformly collected at turnstiles. (Cleveland, in the off-peak period, offers an interesting example of 1-person-operated, pay-as-you-enter fare collection on a rapid transit line.)

Special care must be taken with fare-collection procedures at transfer stations to avoid delaying transferring patrons. The Toronto Transit Commission uses the technique of the fare-paid platform. With this technique, passengers transferring from one vehicle to another need not use a piece of paper to indicate that they have paid their fare. Because access to the platform is limited to those who have already paid (fare collection for passengers entering the system at this point takes place through a turnstile at the station entrance), people can board and alight through any of the doors on any of the buses or streetcars.

Toronto's fare-paid platform system works well where volumes of passengers justify a major station facility; fare collection is by turnstile for new passengers. Unfortunately, many of the situations where people must transfer from bus to bus or bus to light rail transit do not warrant such extensive treatment. In these cases and with the present fare scheme used in North America, all boarding passengers must file past the driver for transfer inspection. A number of European systems, including Frankfurt, Munich, Hamburg, Amsterdam, and Vienna, use a self-service fare system that overcomes this problem. With self-service fare collection, the passenger does not have to pass by the driver to have the fare collected or the transfer verified. The passenger may board or alight at any door and, if he or she does not possess a monthly pass or a valid transfer, he or she purchases it from a ticket machine that is mounted either at curbside or on the transit vehicle itself. Passengers on board transit vehicles are inspected at random by ticket inspectors who levy a tariff surcharge (usually amounting to several times the fare) to those passengers who are traveling without valid tickets. These self-service fares are time based or a combination of time and distance based. The time-based fare is, in effect, a 1-h transit pass similar to the monthly pass used by some North American systems.

The ability to board and alight through any door offered by self-service fare means not only that interchange between various routes and modes can be made easily but also that boarding on the street can take place rapidly and shorten present times by one-half or two-thirds. Because transit vehicles in downtown areas spend about half their time stopped and about half that is taken up with boarding and alighting, some significant economies in the overall transit system are possible with the self-service fare.

### How to Achieve Service Integration

In a large metropolitan area, usually more than 1 carrier is involved in providing public transport service. How can one achieve service integration in circumstances such as this? How does one encourage a bus carrier to route buses into the appropriate rapid transit, light rail transit, or commuter train station when the carrier might prefer to run these buses directly into the CBD? These problems are real. They are sometimes handled by a cooperative effort among carriers. But, in recent years, a new organizational form has emerged to promote this type of integration. This organizational form, referred to as a transport community or a public marketing agency, first appeared in its full modern version in Hamburg in 1966 (17, 18). An agency was set up as a creature of both government and the carriers; it has the responsibility for planning and marketing all transit services. Thus the integration of transit services and collecting and redistributing revenues are ensured. This organizational format has been formed in a number of other European cities, and variants of it can be found in Toronto (GO Transit), Vancouver (Greater Vancouver Transit System), and San Francisco (the emerging Metropolitan Transportation Commission). These public marketing agencies can be carrier associations, creatures of senior government, or a combination of agencies (19). Whatever they are and however they are structured, they offer a means of ensuring the integration of public transport services in what can otherwise be very trying circumstances.

## SUMMARY

As with any other form of public transit, light rail services can be arranged to operate as single entities, or they can be organized into an interacting system. The latter approach results in a system more useful to the community and in more riders and revenue for the transit company. It does require greater management effort if the necessary service integration is to take place. With time and effort, the integration elements described in this paper will be available and will offer North Americans a truly attractive alternative to the automobile for a substantial portion of urban travel.

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