Public transport network planning: a guide to best practice in NZ cities

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Abbreviations and acronyms

ARTA	Auckland Regional Transport Authority
CBD	central business district
CCC	Christchurch City Council
ECan	Environment Canterbury
GPS	government policy statement
GW	Greater Wellington Regional Council
NZ	New Zealand
NZTA	New Zealand Transport Agency
VKT	vehicle kilometres travelled
ZVV	Zürcher Verkehrsverbund (Zürich Regional Public Transport Agency)

Contents

Executive summary

The purpose of this research was to explore the potential for implementing the 'network-planning' approach to the design of public transport services, to significantly improve both patronage and efficiency in the use of public subsidies in the urban regions of Auckland, Wellington and Christchurch. The research was carried out between September 2008 and October 2009.

The challenge for public transport seems daunting. To achieve environmental and social objectives, public transport must cater for travellers with very different needs, ranging from peak-period access to the CBD to all-day access to local shops and community centres. It must provide attractive service frequencies and operating hours to a wide range of destinations, while also maintaining high occupancy rates. Many observers have argued that the trade-offs present an insoluble problem – but there is evidence to counter this assertion.

Successful public transport systems in Europe and North America have managed to serve commuters, shoppers and car-less people, while also combining high service levels with good cost recovery. Some features of European cities, such as high population densities and limited space for cars, have made it easier for them to achieve these outcomes, but service planning philosophies and strategies are also critical to success. This report explores an essential element of service planning, which has come to be called the 'network approach', or network planning.

One approach to diverse, 'anywhere-to-anywhere' travel patterns is to provide 'tailor-made' services for different travel markets: express buses and trains for peak commuters; regular buses for local trips along busy corridors; and services (such as 'dial-a-bus') without fixed schedules for low-demand corridors and times. The problem with this approach is that the more public transport is tailor-made, the more it surrenders its environmental and economic advantages.

The alternative is networks. Instead of having tailor-made public transport, the introduction of transfers can enable provision of a 'ready-made' service. This approach enables 'anywhere-to-anywhere' travel with high occupancy rates by carrying different kinds of travellers on the same services. By being organised around transfers, a public transport system can offer access to a large number of potential destinations at an affordable cost to the operator. Traditional public transport planning has treated transfers as an inconvenience to be avoided at all costs, but the network approach makes them the building blocks of a multidestinational system. While transfers present many new travel opportunities, they also impose inconvenience. Creating effective transfer-based public transport systems requires careful planning to ensure that the inconvenience is minimised.

There is clear evidence that impressive results have been achieved though network planning for public transport services in many European and North American cities. Patronage levels have grown considerably, while efficiency in the use of the public subsidy has improved.

To provide examples of 'best practice' in public transport service design, we selected three overseas cities that had similar characteristics to each of the New Zealand cities in terms of urban form, demographics and public transport infrastructure. The intention was to reveal, as far as possible, the impact of the approach to public transport service design on patronage levels and efficiency in the use of resources.

The comparator pairs chosen for this research were Auckland and Vancouver; Wellington and Zurich; and Christchurch and the Swiss town of Schaffhausen. The choice of a comparator for Christchurch was the most difficult. Although there are cities of comparable size with successful public transport, such as Freiburg in Germany, these have well-developed heavy- and light-rail systems. In the absence of a

good comparator, we have included possibly the most successful all-bus urban transport system in Western Europe.

Comparisons were based on population, residential density across the urban region, jobs in the CBD, mode share for the journey to work, public transport boardings, public transport service-km, and the level of public subsidy required per public transport boarding.

The comparisons revealed that New Zealand's three largest urban regions have considerable potential to build on the increases in public transport patronage and mode share that have been achieved during the last decade. Encouragingly, the greatest potential for improvement seemed to lie with 'non-traditional' trip types, which could be accommodated without imposing commensurate increases in capital and operating costs.

The research also investigated current public transport operating practices in Auckland, Wellington and Christchurch, and found that these practices reflected the broad history of decisions made in transport planning in each city over recent decades.

Because of its smaller size and relative coherence in the institutional history of public transport service planning and delivery, Christchurch had been able to develop or preserve a number of important features of the network-planning approach, most notably a ticketing system that did not penalise passengers who made transfers. Its cross-town 'Orbiter' line, introduced in 2000 at the same time as common bus liveries and the unifying 'Metro' brand, had achieved a level of transfers that exceeded the expectations of local planners. However, in both Auckland and Wellington, we found that the ability of private operators to run 'commercial' services at will had hampered efforts to coordinate services and had allowed perverse competition between different public transport modes to continue. In Auckland, particularly, obvious opportunities to significantly reduce journey times through better coordination of rail and bus timetables had been overlooked.

Practical experience in the international comparator cities and elsewhere suggests three key areas of change that would improve public transport service planning in New Zealand cities:

1 Appropriate institutions and public processes:

- Establish a public agency to plan the network across the whole urban region.
- Redirect private-sector competition into producing best-value tenders for the delivery of part, or all, of a publicly planned system.
- Use well-designed public education and consultation programmes to manage changes.
- Provide a simple fare system that avoids the imposition of penalties for transfers.

2 Network structure:

- Provide a simple and stable network of lines throughout the day.
- Base mode choice for different lines in the network on required capacity, comfort and speed.
- Consider locations for suburban interchanges on the basis of predicted travel patterns and efficient vehicle operations.

3 Network operations

- Simplicity and directness:
  - Organise the network on the principle of 'one section – one line'.
  - Avoid deviations in the physical routes chosen for bus services.

  - Provide pendulum lines through key activity centres and interchanges.

- Speed and reliability:
  - Aim for travel speeds comparable to, or faster than, door-to-door travel times that can be achieved by car.
  - Provide on-road signal and traffic-lane priority to allow buses to meet connections.
  - Aim to have vehicles stopping only as required to pick up and drop off passengers.
- Frequency:
  - Establish 'forget-the-timetable' headways (10 minutes or less) in key travel corridors.
  - Set up integrated timetables outside high-frequency areas.
- Location of stops and access to services:
  - Carefully plan the location of stops to minimise the number of stops and ensure their optimal location in relation to major trip attractors, intersecting lines and pedestrian accessways.
  - Locate stops in car-free precincts close to important destinations, to give public transport a significant competitive advantage.
  - Change current access to 'trunk' services from 'park-and-ride' facilities to access by walking, bicycle, or feeder bus, in order to cater for long-term growth in patronage.
  - Ensure that walking distances between services in interchanges are very short: preferably no more than 10 metres.
- Marketing for first-time and occasional users:
  - Create a simple line structure that makes the network easy to understand.
  - Use maps, on-line information, vehicle livery and on-board displays to reinforce understanding of the line layout and transfer opportunities.

While regional land-use planning in New Zealand cities has been increasingly recognising the need to promote transit-supportive urban forms, in particular by discouraging scattered and very low-density development, these policies cannot, on their own, ensure that public transport will improve. However, when coupled with the network approach to the design and delivery of public transport service, important gains could be made.

Although further research is needed to quantify the specific benefits, it is clear from the directions outlined in this report that considerable potential exists to improve public transport at an affordable cost and in ways that can significantly contribute to the government's strong economic growth agenda.

Abstract

This research explores the potential for the 'network-planning' approach to the design of public transport to improve patronage of public transport services in Auckland, Wellington and Christchurch. Network planning, which mimics the 'go-anywhere' convenience of the car by enabling passengers to transfer between services on a simple pattern of lines, has achieved impressive results in some European and North American cities, where patronage levels have grown considerably and public subsidies are used more efficiently.

Three overseas cities provided examples of 'best practice' in public transport service design to compare with services in Auckland, Wellington and Christchurch. The comparisons revealed that New Zealand's three largest urban regions had considerable potential to build on the increases in public transport patronage and mode share that have been achieved during the last decade.

Current public transport operating practices in Auckland, Wellington and Christchurch were assessed and key areas were identified in which public transport planning could be improved – namely:

- A public institution is required to plan a network across the whole urban region, to let best-value tenders for the delivery of part or all of this system, and to manage the political processes of change.
- Successful network operations require simple and direct lines; 'forget-the-timetable' frequency in key corridors; and marketing that targets new and occasional users.

1 Introduction

This report presents the findings of research carried out between September 2008 and October 2009 for the NZTA 2008/09 research programme.

The purpose of this research was to contribute to improvements in the planning and design of public transport services in New Zealand cities, particularly in Auckland, Wellington and Christchurch.

Current passenger transport systems in New Zealand cities are overwhelmingly reliant on private cars. The future risks of this dependence on cars – increased social and economic costs and environmental impacts – mean that cost-effective and less-polluting alternatives must be found to efficiently serve the urban transport task. Faster and more convenient travel by public transport is needed to replace longer urban journeys and to maximise the efficient use of existing roads.

Because of their relatively small populations and dispersed patterns of settlement, New Zealand cities face significant challenges in creating high-quality public transport services that are a viable alternative to the car. Complementary policies in urban planning, infrastructure investment and transport demand management are required to increase patronage of public transport modes. Recent research suggests that 'network planning' is the critical element in making public transport successful in small-to-medium-sized cities.

In the more successful European and Canadian urban public transport systems, network planning is central to designing public transport services that can offer a competitive alternative to the car for urban travel. Network planning creates maximum flexibility for travellers by making it easy for them to transfer between different services or modes.

This report begins with a review of existing international literature in which the principles of network planning are described, and the evidence for achievements in increased patronage and more efficient use of public subsidies is assessed (section 2).

Section 3 then establishes the potential for achieving similar benefits in New Zealand through a process of benchmarking Auckland, Wellington and Christchurch against international comparators on a range of parameters covering urban form and public transport performance. The purpose of these comparisons is not to suggest that precise imitation of public transport policies is possible or desirable, but rather to establish that an opportunity exists to improve considerably on current performance. The comparator cities were chosen because of their similarities to the New Zealand cities on a range of factors known to influence public transport performance, and on the availability of useful data on travel patterns and operating conditions.

Section 4 presents a summary of current public transport operating practices in Auckland, Wellington and Christchurch. These practices reflect the outcomes of the various competing forces in transport planning in recent decades in each city.

The major findings of the research are presented in section 5. Here, we describe the practical application of the 'network-planning' approach to the specific conditions found in New Zealand cities. Issues included in this analysis are:

- institutions and public processes
- network structure
- network operations
  - simplicity and directness

- speed and reliability
- frequency
- attention to location of stops and access to services
- marketing – providing good information for first-time and occasional users.

The policy framework, at regional and national levels, is crucial to the future implementation of an effective public transport network. Section 6 provides a summary of current policies in effect across the whole transport system in New Zealand, pointing out those that are supportive and others that tend to act against the goal of achieving improved patronage and efficiency in the operation of public transport in New Zealand cities.

In the final section, we present our recommendations – that the development of detailed plans for networked public transport services in Auckland, Wellington and Christchurch would provide a strong basis for future government expenditure in public transport. Developing such plans would require the allocation of significant resources from public transport agencies and governments, with the benefits of ensuring cost-effective operations that maximise short-and medium-term growth in patronage, and identifying long-term requirements for future capital investment in new rolling stock and infrastructure.

2 The network approach: meeting many objectives

2.1 Introduction

Public transport is increasingly required to serve a range of objectives – from providing mobility to the disadvantaged through to alleviating traffic congestion – while also making efficient use of financial resources. These different objectives often conflict. For example, commuters to city centres prefer fast radial services, while disadvantaged people without cars often want access to destinations in their local areas; reducing congestion and environmental problems suggest a focus on increasing peak-period patronage, but this may lead to poor financial outcomes by leaving staff and vehicles underutilised at other times.

Many cities in Europe, and some in North America, have successfully met these challenges, providing public transport that serves the needs of local travellers as well as city-centre commuters, and combining environmental benefits with modest public subsidies and high cost-recovery ratios. Of course, European cities, with historic city centres and high population densities, are very different from those of New Zealand and Australia. It is often assumed that these differences provide a complete explanation of the much greater role played by public transport in such places.

Relatively little attention has been paid to the public transport planning philosophies and practices underlying successful systems in Europe and North America. This report explores the central element of those operating philosophies: the 'network-planning approach'. It suggests that the network approach can be used in smaller, lower-density cities as well as in large, dense metropolitan cores. It draws on the European Union's HiTrans project[1] (which applies network planning to smaller cities and towns in Europe) and extends the approach to include New Zealand's three largest cities. It seeks to evaluate the potential for network planning to produce public transport systems that more effectively serve region-wide travel needs, while ensuring efficient utilisation of resources.

2.2 Objectives for urban public transport

The historic function of public transport has been to provide mobility for people without access to cars. Fifty years ago this meant the great majority of New Zealand urban dwellers, but by the 2006 census, only 8% of New Zealand's households were without cars.[2] However, this still amounted to 113,000 households nationally, most of which were in major cities, and to this number must be added people living in households that have cars but who are unable to drive because of age, disability or other reasons. Many of these people are not in the workforce, and their travel needs are focused on access to education, shopping and community facilities. This gives rise to spatially and temporally diffuse travel patterns that, when combined with the relatively small number of carless households, mean that the travel needs of the carless can be difficult to serve economically with traditional public transport systems.

1 HiTrans is an EU-funded cooperative research project involving city and transport agencies in the UK and Scandinavia. It produced five best-practice guides on various public transport planning themes (www.hitrans.org).

2 Statistics New Zealand: 2006 Census Regional Summary Tables, table 14 ('not elsewhere included' subtracted from total).

In most cities, public transport plays a role in alleviating traffic congestion, parking difficulties and the environmental impacts of commuting by automobile. These problems are most serious in central business districts (CBDs), and commuter public transport has historically focused on the CBD market. Commuter services have provided direct access to the CBD in peak periods, with minimal or no service in off-peak periods or to non-central locations. Commuter transit suffers from underutilisation of staff, infrastructure and vehicles – many buses or trains make only one full return trip per day, making it difficult to cover the costs.

In many cities, public transport is essential to the economic viability of the CBD. The vital commercial hearts of New York or London could not function without public transport, which carries the great majority of workers, shoppers and other visitors. In the 1960s and 1970s it became fashionable to argue that smaller cities, such as those in New Zealand, did not require traditional CBDs, and that retailing, entertainment and much employment should be decentralised to suburban centres. However, since the 1990s, urban economists have realised the importance of 'agglomeration benefits' in supporting economic growth in an 'information economy'. This has led to a renewed focus on prosperous CBDs and subcentres, and the effective public transport systems needed to support them (Abusah and de Bruyn 2007). To contribute to productivity in this way, public transport needs to move beyond the traditional commuter role, and also serve shoppers, tourists and business visitors.

Finally, there is the problem of sustainable development, highlighted by the twin challenges of climate change and insecure oil supplies. As noted by the New Zealand government, the availability of public transport can help mitigate the effects on households of volatile oil prices (Government of New Zealand 2009, p17). Public transport is more environmentally efficient than car travel – provided occupancies are sufficiently high – and it can indirectly promote walking (Mees 2010). The environmental challenge dovetails with economic efficiency, which also requires adequate occupancy rates. Empty trains and buses do not generate sufficient revenue to cover a reasonable share of their costs; nor do they produce better environmental results than the private car.

The challenge for public transport seems daunting. Serving all the different objectives noted above involves catering for travellers with very different needs, ranging from peak-period access to the CBD to all-day access to local shops and community centres. It also involves providing attractive service frequencies and operating hours to a wide range of destinations, while also maintaining high occupancy rates. Many observers have argued that the trade-offs present an insoluble problem – but there is evidence to counter this assertion.

Successful public transport systems in Europe and North America have managed to serve commuters, shoppers and people who don't have cars, and also combine high service levels with good cost recovery. Some features of European cities, such as high population densities and limited space for cars, have made it easier for them to achieve these outcomes, but service-planning philosophies and strategies are also critical to success. This report explores an essential element of service planning that has come to be called the 'network approach', or network planning.

2.3 Network planning

The essential purpose of public transport is to carry people with different trip origins and destinations in the same vehicle. These travellers can be transported with lower economic and environmental costs than if they travelled separately. However, as homes and workplaces become more and more dispersed, public transport faces an increasing challenge regarding the range of trip origins and destinations.

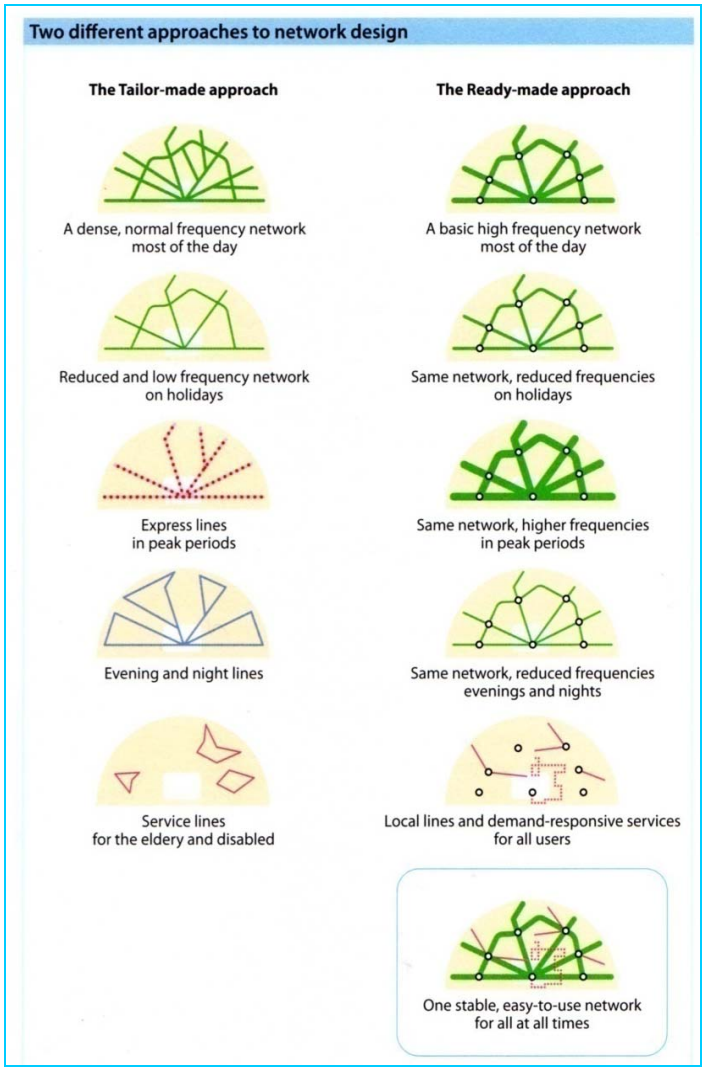
One approach to having diverse, 'anywhere-to-anywhere' travel patterns is to provide 'tailor-made' services for different travel markets: express buses and trains for peak commuters; regular buses for local trips along busy corridors; and car-like paratransit[3] for low-demand corridors and times. The problem with this approach is that the more public transport is tailor-made, the more it surrenders its environmental and economic advantages. A public transport system offering a direct service between every origin and destination would have low frequencies, low occupancies, high costs and high greenhouse gas emissions per passenger. Taxis already provide this kind of service in most cities, and while an important part of urban life, they are not cheap and, without changes to the fuel source, do not reduce greenhouse gas emissions or fossil-fuel consumption.

The alternative is networks. Instead of having tailor-made public transport, the introduction of transfers can enable the provision of a 'ready-made' service. This approach enables 'anywhere-to-anywhere' travel, with high occupancy rates, by carrying different kinds of travellers on the same services. Visitors to Paris soon learn that this is how the city's Metro works: nearly every trip requires a transfer, but transfers are free and high frequencies ensure minimal waiting. Even in the dense urban setting of Paris, it is not economically feasible to provide high-quality, transfer-free services; in dispersed environments, the difficulties are even greater.

The difference between the 'tailor-made' and 'ready-made' approaches is illustrated in figure 1.1. The idea behind the 'ready-made' model is to provide a stable network of routes, or 'lines', that operates consistently and at high standards throughout the day and week, catering for as many different trip types as possible with as few different lines as possible.

3 Modes of public transport (for example, dial-a-bus) that do not follow fixed routes or schedules.

Figure 2.1 Two different approaches to network design (Nielsen 2005, p35)



The key operational elements of the network approach are:

- integration of all modes with easy and comfortable transfers at multiple locations across a city region
- a clear and consistent 'line' structure that is easy for users to learn and understand
- direct routes, enabling fast operating speeds
- high frequencies where demand is sufficient, and coordinated timetables elsewhere.

This approach relies on the efficiencies created by what has come to be called the 'network effect'. This can be illustrated through the example of a hypothetical dispersed, low-density city called Squareville (see figure 2.2).

Figure 2.2 The network effect: the 'Squareville' example (Nielsen 2005; p86; Mees 2000)

The network effect: the "Squareville" example

1 "Squareville" with ten bus lines running north–south

The hypothetical city of "Squareville" has a grid-iron street pattern. The streets are well suited for a bus service since they are 800 meters apart. "Squareville" is a homogeneous city with a travel demand that is entirely dispersed. Assume the area around each of the city's street crossings generates one journey to every other street crossing; 9900 trips per day in total.

For the whole of "Squareville", the ten bus lines can only serve 900 trips in the city, which is less than 10 percent of the total trips of 9900. Assume that the public transport service presently attracts one-third of the journeys it can theoretically serve. This gives 300 trips per day by public transport, which is a modal share across the whole city of only 3 percent.

2 "Squareville" with ten bus lines running north–south, double frequencies on all lines

Imagine that services on the existing bus lines are doubled in order to make more people in "Squareville" to use public transport. According to traditional transport demand modelling the elasticity of demand might be assumed to be some 0.5. This means that a 100 percent increase in service will produce a 50 percent increase in demand. The result will be 450 public transport trips per day and a modal share of 4.5 percent. Since the operational costs are likely to increase by more than 50 percent, the cost-recovery through fares is likely to fall.

3 "Squareville" with twenty bus lines running north–south and east–west

Imagine that the extra operating resources instead were used to run ten new bus lines in the east-west direction. This would create a grid network of twenty lines. The number of trips that are directly served would double to 1800; the 900 initial north-south journeys and the 900 new east-west journeys that can be made without transferring between lines. But if passengers are willing to transfer, then all 9900 trips between all blocks can be served by this network; 1800 directly and 8100 by transferring. Assume that the modal share for journeys involving a transfer is half of that for direct journeys, i.e. one-sixth of these trips that can be attracted to public transport. This gives a total number of 1950 public transport trips per day (1800/3 + 8100/6). The modal share has increased dramatically from 3 to 20 percent.

This gives an elasticity of demand that is 5.5, rather than the traditional figure of 0.5. Increased revenue from the fares should more than cover the extra costs of operation and vehicle occupation would rise.

(Adapted from Paul Mees, 2000).

'Squareville' illustrates the key idea behind network planning: serving the maximum number of possible journeys with the minimum of operational resources. Obviously, this is only a model, and real-world cities will have their own individual requirements, but it illustrates the fact that transfer-based systems can create large resource savings while simultaneously opening up new travel possibilities. This provides a way around the low elasticities of demand found in traditional transport studies, which have suggested that patronage increases less rapidly than the rate at which new services

are added, leading to steadily decreasing occupancy rates. The network effect enables services to be added in ways that increase demand at faster rates than those at which resources are added.

Transfers are the key to the network effect. As the Squareville model illustrates, transfers are integral to a public transport system that offers access to a large number of potential destinations at an affordable cost to the operator. Traditional public transport planning has treated transfers as an inconvenience to be avoided at all costs, but the network approach makes them the building blocks of a multidestinational system.

Two US researchers have commented on the importance of transfers:

> *Surveys asking what passengers like and dislike about transit find that transferring is at or near the top of the list of dislikes. Passengers prefer a direct trip from their home to their job or other destinations. The express bus in some radial systems takes this finding to heart by designing systems based on direct routes from suburbs to CBDs. Transfers are avoided, but at the cost of limiting opportunities for travel to non-CBD destinations. In contrast, the multidestinational approach uses transfers to open travel paths to and from non-CBD destinations that are reachable in radial systems only by lengthy and circuitous travel. The intent is to induce new ridership through the provision of new travel opportunities created by transfers in the belief that the induced non-CBD patronage will exceed any CBD patronage that may be lost due to an added transfer.*
>
> *…The differing views on transferring lead to differing views of suburban bus lines. In the multidestinational approach, suburban bus routes are neither parallel routes to the CBD nor specialized 'feeder routes' to trunk lines running to the CBD. Rather, they are treated as general purpose routes that interlock with each other through transfers to make intrasuburban mobility possible, while also feeding passengers onto trunk routes or dispersing passengers from trunk routes. It is as accurate to say that a rail or bus regional trunk line is a feeder to suburban bus lines as it is to say that bus lines feed the trunk line, or that suburban bus lines feed other suburban buses* (Thompson and Matoff 2003, p298).

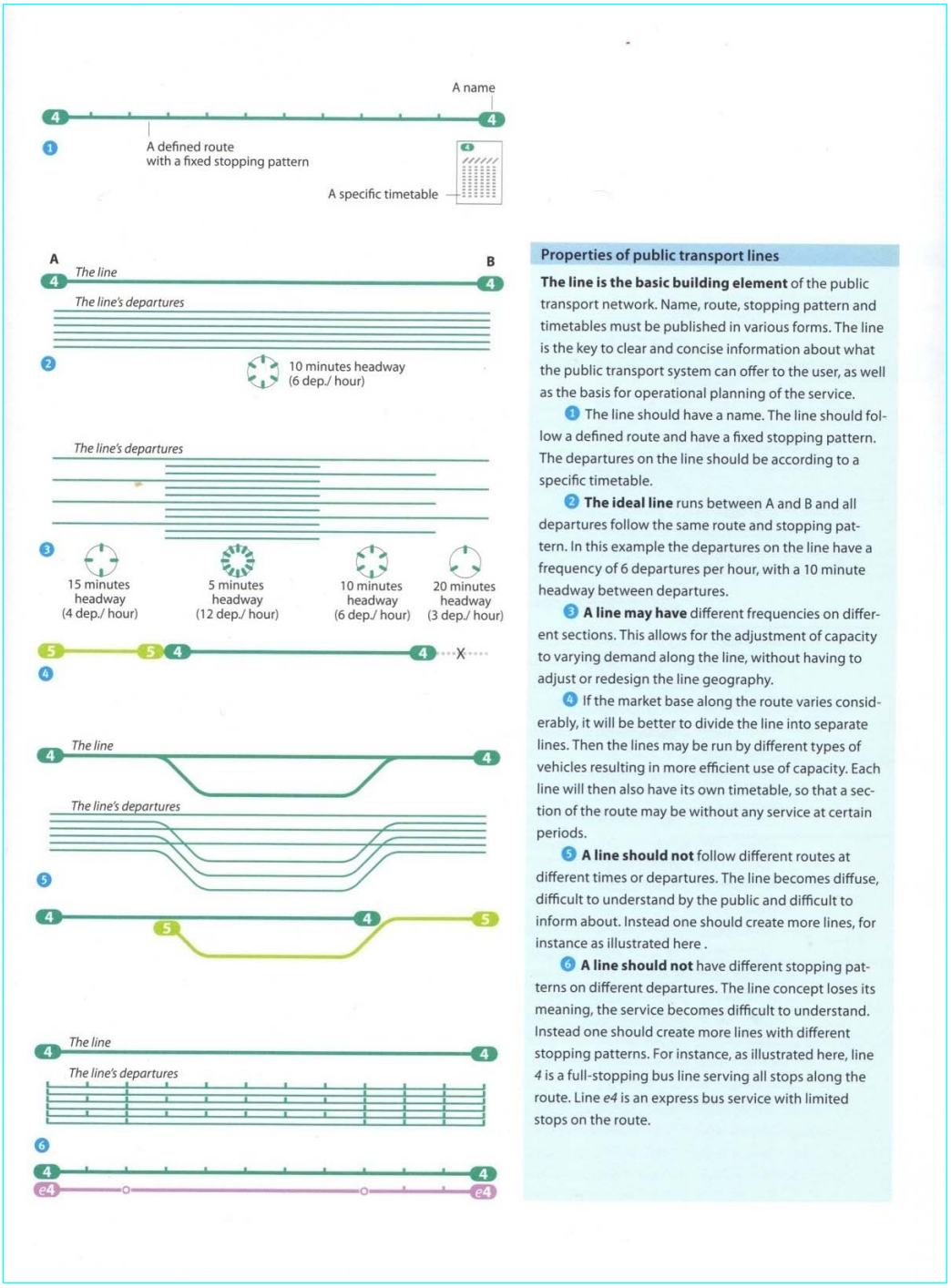
While transfers present many new travel opportunities, they also impose inconvenience. Creating effective transfer-based public transport systems requires careful planning to ensure that the inconvenience is minimised as much as possible.

Empirical evidence for the success of public transport agencies in some cities to 'sell' this model of public transport service provision to their communities, and the conditions under which this success was achieved, are discussed in sections 2.5 and 2.6, and in the international comparisons with New Zealand cities in section 3.

2.4 Elements of network planning

The basic idea is to transform a traditional public transport system, consisting mainly, or entirely, of low-quality routes, into an integrated network of high-quality services.

Figure 2.3 Creating a high-quality network (Nielsen 2005, p95)



Properties of public transport lines

The line is the basic building element of the public transport network. Name, route, stopping pattern and timetables must be published in various forms. The line is the key to clear and concise information about what the public transport system can offer to the user, as well as the basis for operational planning of the service.

1 The line should have a name. The line should follow a defined route and have a fixed stopping pattern. The departures on the line should be according to a specific timetable.

2 **The ideal line** runs between A and B and all departures follow the same route and stopping pattern. In this example the departures on the line have a frequency of 6 departures per hour, with a 10 minute headway between departures.

3 **A line may have** different frequencies on different sections. This allows for the adjustment of capacity to varying demand along the line, without having to adjust or redesign the line geography.

4 If the market base along the route varies considerably, it will be better to divide the line into separate lines. Then the lines may be run by different types of vehicles resulting in more efficient use of capacity. Each line will then also have its own timetable, so that a section of the route may be without any service at certain periods.

5 **A line should not** follow different routes at different times or departures. The line becomes diffuse, difficult to understand by the public and difficult to inform about. Instead one should create more lines, for instance as illustrated here .

6 **A line should not** have different stopping patterns on different departures. The line concept loses its meaning, the service becomes difficult to understand. Instead one should create more lines with different stopping patterns. For instance, as illustrated here, line *4* is a full-stopping bus line serving all stops along the route. Line *e4* is an express bus service with limited stops on the route.

Four key elements of network planning underpin the creation of high-quality, transfer-based networks.

- **A simple line structure**

  The *HiTrans best practice guide* to network planning (Nielsen 2005) distinguishes between 'routes' and 'lines', as illustrated in figure 2.3. A route is defined (as in the standard usage of the word) as 'the physical path traversed by a public transport vehicle'. However, it useful, particularly in discussion of the planning and operation of bus services, to have a separate term, 'line', as an operational element in a public transport system. Therefore, in a planned network, a bus 'line' would have a defined and unchanging physical route with a fixed stopping pattern, a specific timetable, and a unique name and number. The idea, in part, is to give bus services something of the coherence and permanence of train and tram lines.

  Simplicity offers two important benefits: it makes the network easier for passengers to understand, and it reduces resource requirements by limiting the number of lines that an operator must provide. Although there are some occasions in weaker markets where multiple lines might operate in a single corridor, creating simple structures generally means using only one line in a corridor: the Paris Metro provides an excellent illustration of this concept in operation.

- **Stable line and operating patterns**

  As well as being simple, a network must also be stable. As figure 2.1 illustrates, the idea is to provide a consistent, high-quality service across the network all day, rather than operating different service types in peak, off-peak, night and weekend time periods. Where additional services are required to cope with peak demands, this is done by intensifying the basic service frequencies, rather than by introducing new lines or disrupting the stopping patterns on existing lines. Under this model, the addition of express services might be achieved by adding a new 'line' with the same route as the all-stops line, but with a different stopping pattern. The express may be given a name or number that indicates its relationship to the standard line.

- **Convenient transfers**

  Easy transferring requires attention to timetables and physical facilities. 'Random' transfers are possible when all lines serving an interchange point operate frequently, generally every 10 minutes (six departures per hour) or better. 'Timed' transfers are needed when services are less frequent, and the timetables for connecting lines must be coordinated.

  Coordinated timetables require common service frequencies and hours of operation. If frequencies are the same on all lines, then it is possible to coordinate all arrivals and departures at an interchange to produce a 'pulse timetable'. Typically, this involves all the bus lines to a station arriving shortly before the connecting train, and then leaving soon after the train departs. This allows transfers to be made in all directions, not just to or from the CBD (Mees 2010, chapter 8; Nielsen 2005).

  The physical layout of transfer points is also crucial. Short walking distances, clear signage, and protection from the weather and from anti-social behaviour are the key elements (Nielsen 2005, pp100–101).

- **Appropriate institutions and fare systems**

  Transfer-based networks require transfer-friendly fare systems. This generally means that patrons pay for the distance travelled rather than the number of transfers made, typically through a zone- and time-based fare system. However, it is extremely difficult to arrange systems of this kind when different public transport operators retain their own fare revenue. The division of fares among

different operators is problematic, because in a genuine network, 'weak' lines are cross-subsidised by 'strong' ones in order that the same service frequencies can be provided on all lines serving an interchange. Network planning requires a system for pooling fare revenues to allow cross-subsidy.

The pooling of fare revenues to allow cross-subsidy and free transfers, and the planning of lines on a whole-of-system basis, point to the need for a single agency to take responsibility for planning and funding the network. The European Union's HiTrans project concluded that a regional public transport agency is an essential requirement for an effective network.

Under such a system, individual operators compete for the market, rather than in the market, by tendering for the right to operate lines, or groups of lines, forming part of the network. Such a system is perfectly consistent with the New Zealand Ministry of Transport's objective of 'healthy and fair competition for contracted public transport services' (NZ MoT 2009, p10), since, as the *HiTrans* manual points out:

> *Planning and competition are not necessarily contradictory. It is more a question of appropriate allocation of the roles of the two approaches in the institutional setup* (p11).

The combination of region-wide planning by a public agency and competitive tendering for services is becoming increasingly popular in Europe, having achieved positive results in London, Copenhagen and Swedish cities. It is also being introduced for buses in Singapore, under that country's most recent land transport strategy (Land Transport Authority of Singapore 2008, pp38–39).

In Australia, these institutional arrangements are in place in Perth, where public transport patronage has grown steadily since the early 1990s (Stone 2009), and in Adelaide, where political support is emerging for service improvements that have good potential to improve patronage levels.

2.5 Does network planning deliver?

The first comprehensive comparison made between network planning and the more traditional approaches was Mees' analysis of public transport in Melbourne and Toronto in 2000. This demonstrated that two cities with similar populations, incomes and urban forms had experienced very different public transport outcomes. Per-capita public transport usage in Toronto was at least twice as high as in Melbourne, despite a much smaller rail system and significantly lower public subsidies. Toronto's superior performance was the result of network planning by a single public agency that offered travellers frequent and direct bus services, as well as easy physical connections at subway stations and with other buses at street corners. Melbourne's poor performance was due to indirect, infrequent and poorly connected services – these were the consequence of unproductive competition between two public agencies with separate responsibilities for train and tram services and a plethora of private bus companies (Mees 2000).

Subsequent analysis of a group of US cities has confirmed the benefits of network planning. Thompson and Matoff (2003) investigated changes in public transport service levels and patronage between 1983 and 1998 in nine growing urban regions. They found that cities that adopted a network-planning approach significantly outperformed those that adopted a radial/direct-route approach: the 'network' cities recorded higher patronage increases and lower rises in subsidy levels. It is worth noting that all nine cities appeared to have lower urban population densities and higher car-ownership rates than Auckland, Wellington or Christchurch.

Many transport analysts regard Zurich as the 'benchmark' city for public transport. Although its residents are among the wealthiest city-dwellers in the world, they use public transport at very high rates, and importantly, usage rates have been increasing at the expense of the car for at least two decades. The Canton (or State) of Zurich, covering Zurich City, its suburbs and surrounding rural areas, has a similar population to the Auckland region, at around 1.3 million. However, Canton Zurich's residents made 542 million public transport trips in 2007, compared with the 52 million trips made in Auckland (ARTA 2008, p15; Zurcher Verkehrsverbund 2008, p14). In the City of Zurich, 63% of residents travelled to work by public transport at the last census in 2000, while 25% went by car (the remainder walked or cycled); the canton-wide shares were 41% and 47% respectively. In both cases, the public transport share had increased since the previous census in 1990. For trips to school and university across the canton, 31% were by public transport and only 3% by car – the other two-thirds of students walked or cycled (data from the Swiss census reported in Mees 2010, chapter 8).

While Zurich has a substantial inner-city tram system and an extensive suburban rail network, this infrastructure is not remarkable by European standards. Nielsen and other observers agree that the critical factor behind Zurich's superior performance is the very comprehensive network planning covering the city and canton. Excellent services are provided not just for CBD commuters, but for off-peak, cross-city and inter-suburban travellers as well:

> *The main key to market success is the network qualities of the public transport system. It is the integrated, high frequency network with many interchanges, and the stable and reliable operation through several decades that makes the difference* (Nielsen 2005, pp89–93).

And, like most other relatively successful European and North American cities, the 'offer' to Zurich citizens of an attractive public transport network is supported by restrictive policies for such measures as parking and road space allocation for cars, which add to the comparative advantage of public transport over car travel for many trips. (For a more general discussion of the need for a coordinated package of incentives for public transport and disincentives for car travel, see Vuchic 1999.) The relative influence the public transport service can have in shifting travel mode preferences away from the car is reinforced in the example of Schaffhausen, described in section 3. This small town has achieved significant public transport patronage, without imposing major obstacles for car users, through the exceptional quality of its public transport network.

Significantly, while Zurich City has a typically European high population density, the suburbs and rural areas are actually more spacious than the suburbs of New Zealand cities, with many residents living in small villages dispersed through farmland and forest. Zurich has found a way of extending network planning to areas with extremely low population densities.

2.6 How change happens

One common feature of success stories in public transport network planning is the role of the public in bringing about change. Zurich is the most celebrated example. In the 1960s and early 1970s, policymakers sought to replace the city's trams with an expensive underground 'metro' system, but the proposal was twice defeated at referendums. A third referendum, initiated by citizen's groups, proposed upgrading the existing tram and bus lines to provide metro-style services. It was finally passed in the mid-1970s, and the turnaround in the city's public transport fortunes dates from that time. A second successful referendum in the 1980s, this time initiated by the cantonal government, laid the foundations for extending networked public transport to suburban and rural areas (Mees 2010, chapter 8).

These days, general acceptance of environmental and social objectives for transport policy means that citizens' action is no longer necessary to get public transport onto the political agenda. However, public involvement in the planning of service changes is critically important, because there will always be winners and losers in any restructuring of a public transport network. The losers will be those existing travellers for whom current timetables and line structures are convenient; many of the winners will be new patrons whose travel needs are currently not met at all. Unless network restructuring is handled sensitively, with robust community engagement, the beneficiaries of improved services will not have the opportunity to have their say, and the negative reactions of those who find the current arrangements more convenient will dominate discussions.

Many restructurings of substantial networks, such as the US examples discussed by Thomson and Matoff in section 2.5 above, were implemented at the same time as the opening of new rail lines. The attractiveness of a new rail service can provide an excellent context in which to gain support for changes that require transfers.

A good example of this was the recasting of bus services in the southern suburbs of Perth in December 2007, at the same time as opening the Mandurah rail line. The rail line replaced a bus lane along the Kwinana Freeway, which had allowed direct commuter services between the southern suburbs and the CBD. With the opening of the new rail line, direct bus services to the CBD were withdrawn and replaced with feeder lines that doubled as cross-city links.

This reorganisation has significantly improved access to Murdoch University. The campus is about a kilometre to the west of the Kwinana Freeway, and used to be difficult to reach from the east as most bus services from that direction turned north at the freeway and continued to the CBD. Now, bus routes from the east drop passengers at Murdoch Railway Station and continue to the university. The inconvenience of the transfer to and from trains for CBD passengers has been minimised by a well-designed interchange, a multimodal fare system, frequent train services, coordinated timetables, and the fact that the train trip to the CBD is much faster than the previous bus trip. 2009 figures showed that 59% of passengers boarding trains at Murdoch Railway Station arrived by bus (36% used park-and-ride facilities, and only 5% walked), and the railway station was the busiest in suburban Perth, with nearly 7000 daily boardings (Martinovich 2009).

These network changes were planned through a consultative process that ran in tandem with the construction of the rail line. The result has been wide community support and substantial increases in patronage for both city and cross-suburban trips.

Examples of successful network restructurings of all-bus systems are less common. It is often tempting to use the capacity of new facilities, such as busways, to add additional direct services. The busway network in Brisbane provides a current example of this: in each corridor, dozens of low-frequency (half-hourly to hourly) routes run directly from suburban areas to the city centre. Overall patronage carried on the busways is not spectacular by international standards, and the service pattern leads to low occupancies, high subsidies, and confusion and congestion at busway stations. The most successful busway systems – such as those in Ottawa (Canada), Curitiba (Brazil) and Bogota (Columbia) – use larger vehicles for trunk services, and operate like a rail service.

A relatively recent example of a successful all-bus network restructuring is provided by the express trunk bus services in Vancouver. First introduced in 1996, these bus rapid-transit services, branded as B-Line, featured fewer stops and upgraded boarding and interchange facilities. They were provided along heavily trafficked corridors that were ultimately intended for conversion to light rail. The operating costs saved by the restructuring were redeployed to improve service levels on local routes.

A specific example was the change to services between Richmond, a district in Vancouver's southern suburbs, and Vancouver's CBD. Prior to 2001, a large number of low-frequency routes, many operating in peak periods only, ran from different points in Richmond to the CBD, with express sections in the inner city. In 2001, this pattern was replaced with a single, high-frequency, full-time express service (the #98 B-Line). All other bus lines were altered to form feeder or cross-suburban links that connected with #98 at specially designed interchange 'stations'. The B-Line service was operated with articulated buses; local lines were served with conventional vehicles and minibuses.

The trade-off for needing to transfer was a dramatically increased level of service on local sections of line – for example, the line to Vancouver Airport, which previously operated at 30–60 minute intervals, changed to operate every 7–15 minutes. The introduction of the new network was preceded by two years of extensive community involvement, which reduced, but did not eliminate, complaints from passengers who had previously enjoyed direct services to the CBD. However, substantial rises in patronage followed the network changes – daily trips in the Richmond corridor rose from 14,000 (on the entire collection of routes operating in the corridor) to 18,000, and have since increased to more than 20,000. This increase finally settled any remaining controversy. The largest increases in patronage were in reverse-commuting and in local and cross-suburban travel, reflecting the new travel opportunities opened up by the integrated network (IBI Group 2003). Route #98 was replaced by the Canada Line, a new light-rail service, in August 2009.

The lessons from these successful changes are as follows:

- Restructuring of public transport networks requires extensive community involvement at all stages of the process.
- Travellers are more likely to accept additional transfers where clear benefits are gained in terms of speed and frequency.
- It may be easier to introduce change through substantial network overhauls than through piecemeal changes to individual routes or lines.

2.7 Conclusion

The network-planning approach to public transport has produced impressive results in many European and North American cities, with improved patronage being achieved without unduly increasing operating expenses. This approach may, therefore, offer potential improvements for public transport in New Zealand's largest cities. The next section of this report explores this possibility.

3 Benchmarking public transport in New Zealand cities

3.1 Selecting cities for comparison

City regions in Europe and North America have successfully employed the network approach to public transport, to produce services that cater for a wide range of travel needs at an affordable cost in terms of public subsidies. This report explores the possibility that a similar approach could produce significant benefits in New Zealand cities. In order to establish the potential for improvement In New Zealand, this section benchmarks public transport in New Zealand's three largest cities against overseas comparators.

No two cities are exactly comparable, even within the same country. The purpose of the following comparison is not to suggest that, for example, Wellington should adopt precisely the same public transport planning approach as Zurich; or that it could achieve exactly the same patronage or subsidy outcomes. Rather, the purpose is to establish that an opportunity exists to improve considerably on current performance.

Auckland, Wellington and Christchurch are very different urban regions, reflecting the influence of their different histories, topography and economic structures. Wellington, as the national capital, has a strong CBD underpinned by a large base of government jobs. Auckland's transport patterns are significantly affected by the region's location on two harbours and a volcanic field. The management of public transport in Christchurch reflects the different approach that was taken by city and regional political leaders in response to the 1989 deregulation of bus services. Because of these differences, the approach adopted in this report has been to benchmark each New Zealand city against an overseas comparator, rather than to compare them with one another.

Some basic similarities between the overseas and New Zealand cities were required to ensure comparability, such as high incomes that enabled near-universal car ownership, and the absence of explicit demand-management policies such as congestion pricing. Another important criterion was the availability of useful data on travel patterns and public transport operating conditions. Where possible, this data was sourced from census authorities and public transport operators; in other cases we employed the *Millennium database for sustainable transport*, compiled by Professor Jeff Kenworthy and other colleagues from Murdoch University (now at Curtin University, also in Perth) for the UITP (International Union of Public Transport). The Millennium Database contains information for 1995/6 (Kenworthy and Laube 2001). As Auckland and Christchurch were not included in this database, we added data for those cities that was prepared as part of the same project and reported in *Indicators of urban transport efficiency in New Zealand's main cities* (Bachels et al 1999).

3.1.1 The city regions selected for comparison

3.1.1.1 Auckland – Vancouver

Vancouver is a large urban region and, like Auckland, spreads at relatively low densities across a visually spectacular landscape. Both cities have relatively weak CBDs in terms of employment, reflecting the fact that neither is a capital. In each case, the CBD is remote from the demographic centre of the region and water crossings are required to connect it to other parts of the city. One other important similarity is that until recently, buses dominated public transport in both cities. Vancouver's first elevated light-rail line, the Skytrain, opened in 1986, and although the network is currently being extended, at the time of writing most passengers were still being transported by bus.

3.1.1.2 Wellington – Zurich

Zurich has a strong CBD, although it is less dominant than Wellington's (the CBD employment share for Zurich in table 3.1 is an understatement, as Zurich's CBD has spread beyond the boundaries of the historic city centre). Like Wellington, Zurich contains a relatively high-density city centre linked to peripheral settlements by an extensive regional rail system. The mountainous terrain strongly influences the settlement and movement patterns of both regions, with major transport corridors following valleys. The City of Zurich has a population of around 360,000, about 10% less than the entire Wellington region (450,000); the Canton (or State) of Zurich, which includes suburban and rural areas, has 1.3 million residents.

3.1.1.3 Christchurch – Schaffhausen

A good comparator could not be found for the urban region of Christchurch. Although there are cities of comparable size that have successful public transport systems (eg Freiburg in Germany), these have well-developed heavy- and light-rail systems. We could not find a city with a successful all-bus system. We originally considered using the Canadian capital, Ottawa, but its extensive segregated busway network, which functions like a rail system, made comparison with Christchurch difficult.

In the absence of a good comparator, we chose the Swiss town of Schaffhausen – possibly the most successful all-bus urban transport system in Western Europe. Located some 53 kilometres north of Zurich in the canton of the same name, Schaffhausen has been served by buses since trams were removed in the 1960s (the busiest line is served by electric trolleybuses). Schaffhausen is much smaller than Christchurch (350,000) – the entire canton has 75,000 residents, of whom around 43,500 live in the capital (including the adjoining municipality of Neuhausen, which has the same public transport operator) – but its urban public transport system carries a similar volume of passengers. Although the two cities are not closely comparable, we felt there would be useful lessons to learn from Schaffhausen's success.

3.2 Benchmarking data

Data was assembled for the three pairs of cities on a range of indicators covering factors of demography and public transport performance.

This data is set out in table 3.1, followed by a summary of sources and a discussion of various issues in the collection and interpretation of the data.

Table 3.1 Urban form and public transport performance in the three New Zealand urban regions and their chosen international benchmarks

	Auckland	Vancouver	Wellington	Zurich	Christchurch	Schaffhausen
Total population (millions)	1.3	2.1	0.45	1.3	0.35	0.044
Population density (people per ha)	18.9	17.1	22.0	37.6	17.0	36.7
Jobs in CBD (% of total jobs in the urban region)	13.5	12.6	22.0	12.2	16.6	n/a
Share of work trips by: - public transport - walk, cycle - car	 7.0 5.6 87.4	 16.5 8.0 74.4	 17.1 13.4 69.6	 40.7 12.1 47.2	 5.2 12.3 82.5	 40.7 14.9 44.4
Public transport boardings (millions of 'unlinked' trips)	52	283	34	542	16	13
Boardings per capita	40	135	77	417	46	289
Public transport service-km (all modes – millions)	42.3	116.2	24.5	71.9	18.8	2.7
Service-km/capita	32	55	61	57	59	61
Subsidy per boarding[a]	2.54	1.10	1.70	0.45	1.62	1.05

a) Equivalent in $NZ at October 2009 exchange rates

3.2.1 Notes on sources and interpretation of benchmarking data

In each case, information was collated to provide a picture of the 'urbanised area' of each region. Total population, population density, and journey-to-work modal-split data for the international comparators came from the 2000 Swiss census and the 2006 Canadian census. For New Zealand, population data came from the 2006 census, but this source did not yield appropriate population density figures because Statistics NZ does not release data for 'urbanised areas', which are defined as 'the contiguously built-up part of a region, excluding farm and other non-urban land'. Instead, population density figures for the three New Zealand urbanised areas were taken from the Millennium Database project (see the note in section 3.1). Although these figures were for 1995–96, they are likely to be reasonably accurate, as urban population densities alter only slowly over time.

Compared with the New Zealand and Canadian examples, the Swiss population density figures we used were somewhat overstated, because of methodological differences. The Swiss Federal Statistical Office draws urban boundaries more tightly than those used in the other countries, excluding all open space and farmland, even when it is surrounded by urbanised land. Non-urban land of this kind was included in the figures for the other countries – it was not possible to obtain more precisely comparable data.

Employment shares for CBDs were taken from the Millennium Database. Because of variations in the definitions of CBD boundaries, these should be regarded as indicative only. Schaffhausen was not included in the Millenium Database because it is too small, so the relevant figures could not be obtained.

Data for public transport performance in the international examples came from the annual reports of regional transport agencies for 2007 and 2008, supplemented by personal communications with staff. These agencies, and the area for which they provide public transport services, were as follows:

- Zurich – ZVV, covering an area slightly larger than the canton
- Schaffhausen – VBSh, covering Schaffhausen and Neuhausen
- Vancouver – Translink, approximately the same area as the Census Metropolitan Area.

Auckland and Wellington public transport performance data came from annual reports for the Auckland Regional Transport Authority (ARTA) and Greater Wellington Regional Council, which oversee public transport services across the respective urbanised areas and into some small regional centres beyond the urban boundaries. Christchurch figures were provided by the regional authority, Environment Canterbury (ECan), for travel in the City of Christchurch, which since amalgamations in 2006, covers the entire urban area.

We found some significant differences between countries in the way public transport trip-making data was recorded. New Zealand authorities recorded 'unlinked' trips – that is, each leg of a single journey that uses a different mode counted as a separate trip. In contrast, Vancouver authorities reported 'linked' trips, in which a single journey counted as one trip no matter how many transfers were made. In order to make sensible comparisons, we reported all the international trip-making data as 'unlinked' trips. Readers should take care when comparing these figures with other published trip-making data (particularly for Vancouver), which typically quote figures for 'linked' trips.

Interpretation of the service-supply data also requires some caution. For the four cities with trains, rail service was measured in units of train-km, but within and between these cities, the capacity of these trains varied considerably.

The information on subsidy levels for the international cities came from operators' annual reports for 2007 and 2008. New Zealand data was for the 2007/08 financial year and was supplied by Alex Campbell from Greater Wellington Regional Council, based on information supplied to him from other agencies. It included bus, rail and ferry contract payments; concessionary fare payments; and kick-start funding of services. Care is needed in interpreting these comparisons because of the volatile exchange rate movements of the past year or more, which have led to a significant decline in the value of the New Zealand dollar against most major currencies, and a substantial appreciation of the Swiss franc.

3.3 What the data revealed

As would be expected, public transport's share of work trips and per-capita trip-making rates were much higher in the comparator cities than in the New Zealand case studies. However, it is noteworthy that the difference in per-capita trip-making was greater than the difference in mode share for work trips: for example, mode share for work trips was 2.5 times higher in Zurich than in Wellington, but trip-making was more than five times higher. The difference reflected the greater ability of networked public transport to serve dispersed non-work trips.

The case studies had one common feature: public transport mode share and trip-making rates were increasing in all six cities. A range of factors, including rising petrol prices, was driving the increases in New Zealand cities, but the increases had actually begun at the 1996 census, well before petrol prices began to rise. Although a revival of employment growth in the CBDs of all three New Zealand cities was doubtless an influence, the improvements to public transport services initiated by the three regional

councils and ARTA, which was set up in 2004 as a statutory organisation accountable to the Auckland Regional Council, have also played a part.

The fact that patronage was much higher (and continues to increase) in the comparator cities was good news for New Zealand, as it suggested that considerable scope remains to build on the improvements of the last decade. The fact that the difference was more pronounced for non-work trips than for travel to and from work was also good news – it suggested that potential patronage increases could be greatest in the off-peak, local and cross-city markets, which could be served without substantially increasing capacity costs.

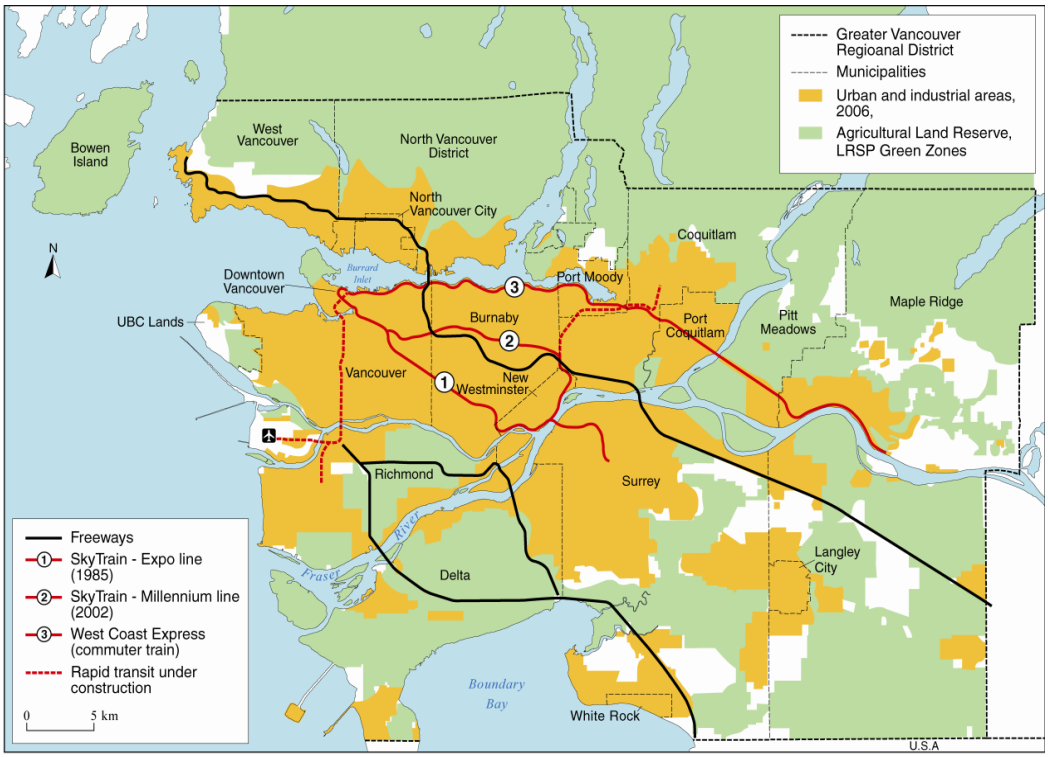
In the comparisons that follow, schematic maps of settlement patterns and public transport services are provided for the international cities. For the New Zealand cities, only Christchurch has a public transport system map that is easy to reproduce in this report.

3.3.1 Comparing Auckland and Vancouver

The urban form of these two cities is remarkably similar, with comparable population densities and shares of employment in the CBD. There is some spectacular high-rise housing in and near the Vancouver CBD, which features prominently in many aerial photos of the city, but this accounts for only a small share of the regional population and has little influence on the regional population density figures. As has already been mentioned, the topography of both cities creates physical barriers to travel.

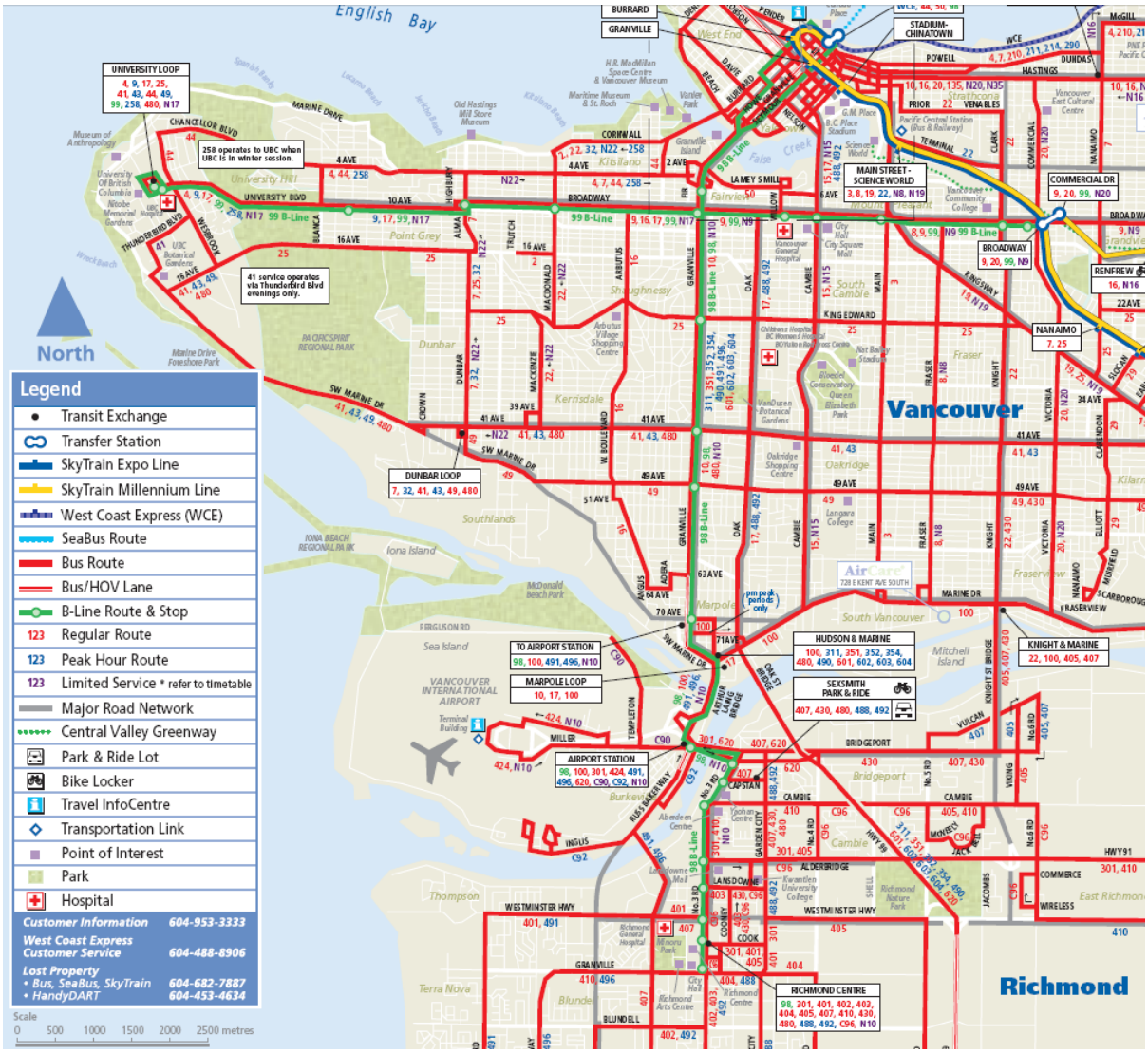
As shown in figure 3.1, Vancouver's urban rail infrastructure is comparable to that of Auckland. Vancouver has two elevated light-rail SkyTrain lines (with a third opened in September 2009) and one diesel-hauled peak commuter rail service; Auckland has two main rail corridors and the Northern Busway. One critical difference is that Vancouver has no radial freeways: its freeway system is confined to two outer-suburban links near the US border to the south, and the Trans-Canada Highway, which crosses the suburbs to the north. By contrast, Auckland has three major radial freeways that converge in a large 'spaghetti junction' that has no equivalent in British Columbia.

Figure 3.1 Broad settlement patterns and transport infrastructure in Greater Vancouver (map drawn by Chandra Jayasuriya, Department of Social and Environmental Enquiry, University of Melbourne)



Vancouver outperformed Auckland in public transport's share of work trips, and by an even greater margin when per-capita trip-making was analysed. Interestingly, Vancouver's much larger patronage was carried on a network that consisted of fewer bus and rail lines (routes) than were provided in Auckland (see figure 3.2). Vancouver had a relatively 'sparse' network made up of heavily trafficked lines; Auckland had a very dense and complex network consisting of many, mainly low-volume, lines. For example, Vancouver's #98 B-Line express bus route carried more than 20,000 passengers a day, while Auckland's 'Northern Express' busway service carried about the same number per week (2004 figures, from Translink 2005). Vancouver's busiest B-Line service was route #99B, an inner-city cross-suburban route serving the University of British Columbia, with 31,000 passengers per day.

Figure 3.2 Part of the Vancouver bus network (Translink 2005)



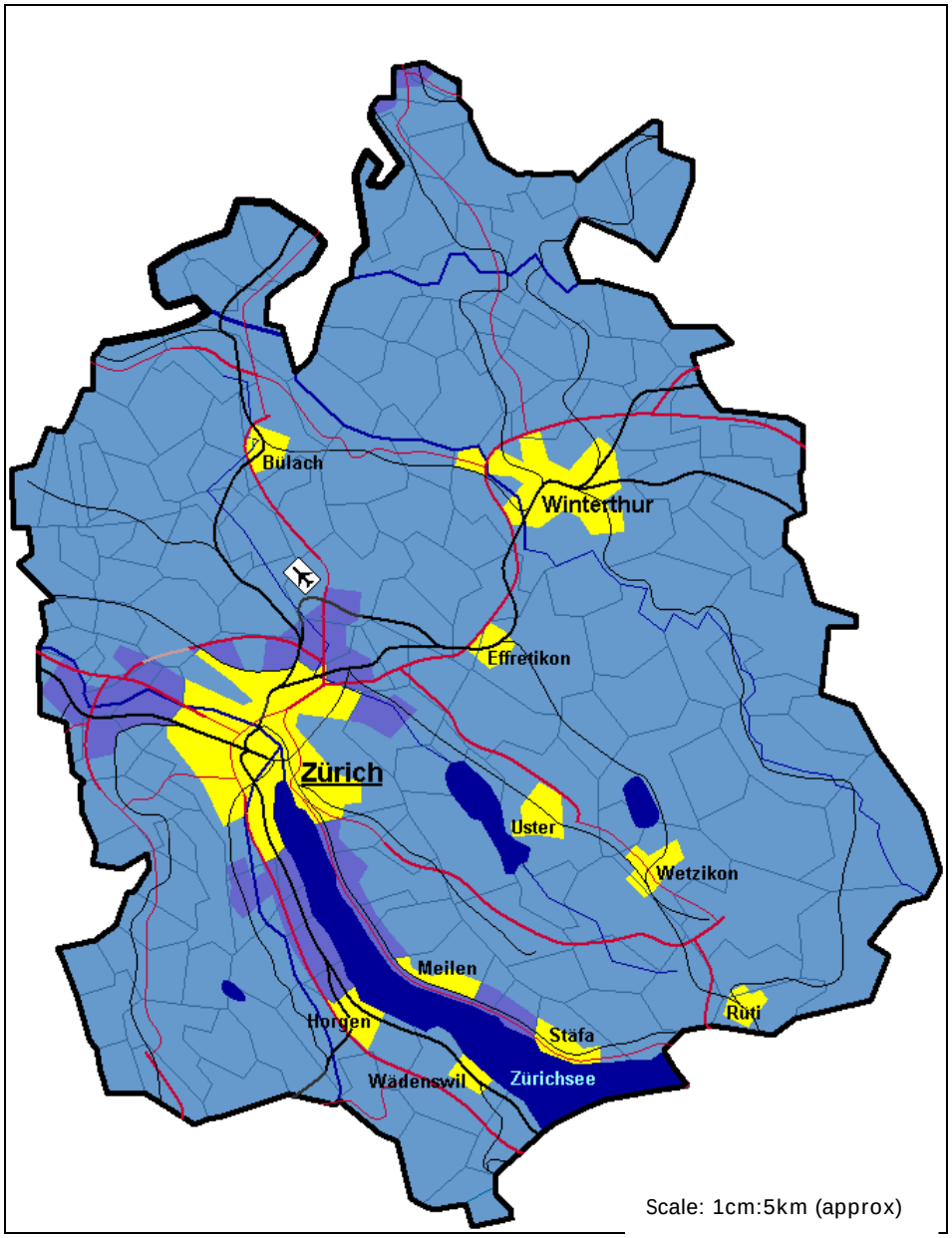
3.3.2 Comparing Wellington and Zurich

Zurich's population density is significantly higher than Wellington's, although the real difference is likely to be less than the apparent 71% margin shown in table 1.1 (Zurich's figures come from a different measuring method). However, the cities are sufficiently similar for lessons to be drawn, especially since Wellington appears to have a stronger CBD than Zurich.

Although only a sketch, the following map (figure 3.3) gives a broad indication of settlement patterns across the whole of the Canton of Zurich, beyond the previously defined Zurich 'urban area' that lies in the south-west corner of the canton.

There are few urban centres (marked in yellow) outside the urban area surrounding the City of Zurich. Of these, only two have populations of more than 20,000 – Winterthur (95,000) and Uster (30,000). Areas of suburban residential development around Zurich City itself are shown in purple. The remaining area (in blue), which takes in the majority of the canton, is mostly agricultural land and forests, with the population housed in small villages.

Figure 3.3 Broad settlement patterns in the Canton of Zurich (www.about.ch/cantons/zuerich)

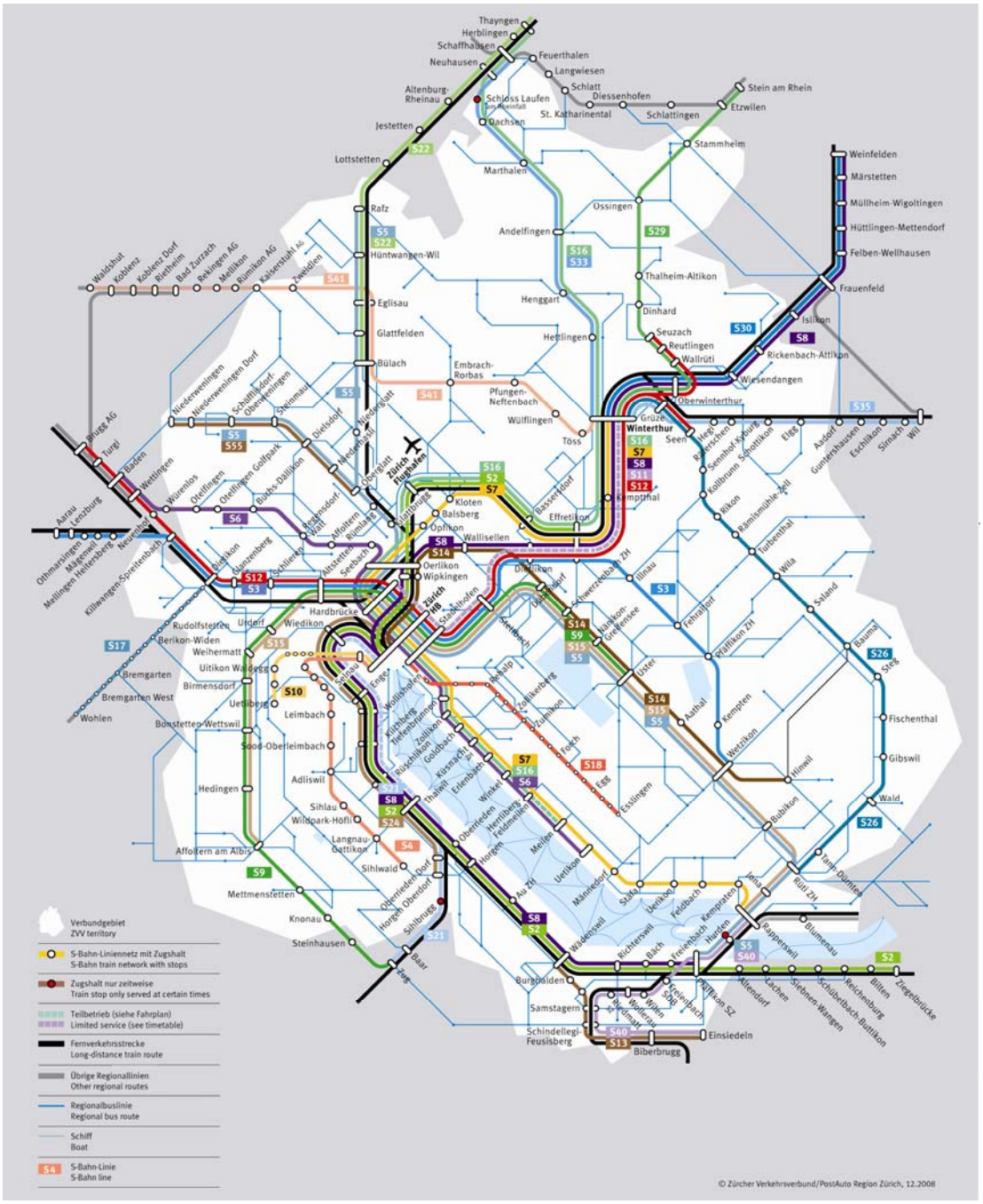


Public transport's share of work trips in Canton Zurich was 2.5 times higher than that of Wellington, and per-capita trip-making rates were more than five times as high, suggesting very strong use of public transport for non-work trips in Zurich. As in the comparison between Auckland and Vancouver, this difference was encouraging because it suggested that future increases in patronage could occur primarily at times and on services with spare capacity.

We found that Zurich's central street-based public transport was very intensively used, with high patronage levels on inner-city tram lines (corresponding to trolley buses in Wellington City). Suburban and regional rail services in Zurich were less intensively used. The higher overall rate of public transport use in Zurich was due as much to the larger number of rail corridors – two dozen as against Wellington's three – as to density of traffic. Zurich had met the challenge of economically operating its large number of rail lines, in areas with very low densities and populations, by integrating them with feeder and cross-suburban bus services (see figure 3.4). By Australasian standards, we found that

Wellington's rail system was very successful, given the relatively low population it served, but the comparison with Zurich suggested a significant capacity for further improvement.

Figure 3.4 The Canton Zurich bus–rail (and ferry) network



Note: Colours represent regional S-Bahn lines:

- black = long-distance national rail
- fine blue lines = bus and ferry services.

3.3.3 Comparing Christchurch and Schaffhausen

The urban forms of these two cities are not very similar, so comparisons should be made with caution. However, Schaffhausen's public transport is so strikingly successful that we believe it offers lessons for

Christchurch and other New Zealand cities – particularly because Schaffhausen is a small city without a medieval core: roads and parking are relatively plentiful and there are few explicit demand-management policies in place.

Public transport's share of work trips was very high in Schaffhausen, at some eight times the level for Christchurch. However, it is important to note that around a quarter of workers who travelled by public transport did so by train to destinations outside the Canton of Schaffhausen – mainly in the suburbs and City of Zurich. When only buses were counted, the difference was around 6:1, similar to the difference in per-capita trip-making rates.

Public transport in Christchurch was different from that in Auckland and Wellington, with a more even spread of patronage between work and non-work trips. Although the share of work trips by public transport was considerably lower in Christchurch than in Auckland, per-capita trip-making rates were somewhat higher, reflecting the fact that Christchurch already employed some features of network planning, such as multimodal fares and the successful Orbiter bus line. However, the comparison with Schaffhausen suggested the potential for further improvement. It was noteworthy that Schaffhausen's 13 million annual public transport passengers were carried on only six bus lines (see figure 3.5), reflecting a similar pattern to that found in Vancouver and the City of Zurich.

Figure 3.5 Schaffhausen bus network (www.vbsh.ch)

3.4 Institutions and policies for public transport

In the three overseas comparator cities, regional public agencies planned, funded and managed public transport: Vancouver's Translink was responsible for roads and public transport; Zurich's ZVV for public transport only; and Schaffhausen's VBSh for buses only. (Canton Schaffhausen also had an equivalent to the ZVV, serving rural areas and integrating urban services with rural buses and inter-

cantonal rail lines.) The Zurich and Vancouver agencies subcontracted some or all of their service offerings to public and private sector bodies, but to the passenger, the overall network appeared to be directly operated by the regional agency (as was the case in Schaffhausen). Fares and timetables were integrated, and the system was marketed as a whole.

As a result of the deregulation of bus services in 1989, the situation in New Zealand cities was different. Until 1 January in that year, regional councils could exercise planning functions in relation to 'contracted' services, but had little ability to influence 'commercial' services provided by private bus firms, even though those services received government subsidies in the form of 'concession recoupment'. In Auckland, in particular, this prevented the development of a multimodal fare system and the recasting of bus services in rail corridors to act as feeders rather than competitors. In Christchurch, a more cooperative relationship between planning agencies and bus operators, and the smaller role of commercial services, enabled a greater degree of public planning and control. This allowed the introduction of a multimodal fare system with free transfers. In Wellington, a significant share of the public transport services were commercially provided. This created problems similar to those seen in Auckland.

Another important difference between the overseas and New Zealand cities was the much higher degree of prominence given to public transport by regional and higher-level governments in the comparator cities. The upgrades to public transport in Vancouver, Zurich and Schaffhausen had come as the result of region-wide debates about transport policy that began in the 1970s. Public transport was seen as the priority mode for urban travel, rather than just a supplement to the automobile. This focus on public transport being the preferred mode for urban travel generally reinforced the network approach, which was designed to provide convenient service for the full range of trip types.

Until recently, public transport in New Zealand has been treated as a 'back-up' mode to the automobile, for the disadvantaged and city-centre commuters. There are signs of a shift in philosophy in the largest New Zealand cities, beginning in Christchurch and now extending to the North Island. However, we found that the public transport infrastructure and operating patterns in all three New Zealand cities still showed the impact of the long period of relative neglect.

3.5 Service supply and public subsidies

As the data in table 3.1 shows, the much higher rates of public transport trip-making in the benchmarking cities were achieved without the need for proportionately larger 'quantities' of service supply. Although the figures were not directly comparable because of differences in vehicle sizes and modes used, it was evident that the New Zealand cities and their international comparators provided a similar order of per-capita public transport service supply.

The big difference was in how this supply was assembled. The attention to network planning in the benchmarking cities was the key to the higher levels of use. By using resources more productively to create a network that delivered higher average boardings per vehicle, the benchmarking cities required significantly lower public subsidies per boarding.

3.6 Conclusion

The comparison with examples of 'best practice' in comparable overseas cities suggested that New Zealand's three largest urban regions have considerable potential to build on the increases in public transport patronage and mode share achieved over the last decade. Encouragingly, the greatest

potential for improvement seems to lie with 'non-traditional' trip types that could be accommodated without imposing a commensurate increase in capital and operating costs. The next chapter of this report considers the three New Zealand cities in more detail, to assess the potential for network planning to improve current operating practices.

4 Current public transport planning practice in New Zealand cities

4.1 Introduction

This section presents a summary of current operating practices in Auckland, Wellington and Christchurch.[4] It provides a basis for our later assessment of the potential to adapt current practices towards the network-planning model, particularly in ways that do not involve substantial additional expenditure.

We found that current operating practices reflected the broader history of decisions made in transport planning over recent decades in each city, and thus represented the outcomes of various competing forces.

4.2 Auckland

4.2.1 Institutions

The impact of the New Zealand government's 1989 deregulation of public transport was most obvious in the Auckland region, where we noted that several private bus companies were operating services that directly competed with each other and with the rail services.

Rail services and some bus services were planned and subsidised by ARTA and delivered by private contractors. Outside this framework, other bus routes were delivered as 'commercial' services, for which operators received fare revenues and a payment from ARTA to offset concession fares. The MAXX brand was used as a coordinating mechanism, but many services operated in the liveries of the private operators.

Through its public transport strategies, ARTA was attempting to coordinate the activities of the private operators and the six local councils in the region.

4.2.2 Service standards

Despite some positive changes associated with the establishment of the Northern Busway, public transport in Auckland did not have a clearly defined network structure.

The train system provided the skeleton of trunk service in the southern and western corridors that, even with current diesel operations, offered competitive travel times when compared with buses.

Buses operated in direct competition with the trains. Services were chiefly oriented around city-bound commuter markets, with low frequencies during off-peak periods and in counter-peak travel directions.

Many bus services competed directly with trains for travel into the city centre despite trains holding a significant competitive travel-time advantage – for example, peak-period express buses from New Lynn took 50 minutes to reach Britomart, compared with 33 minutes by train; Papakura to Britomart took 80 minutes by peak express bus, compared with 53 minutes by a stopping-all-stations train and 38 minutes by express train. Other counter-productive competition between rail and bus was seen in

4 Timetables used in this analysis were those in operation during the last quarter of 2008.

the parallel services offered along rail corridors in the outer suburbs – for example, between Swanson and Henderson in the west, and between Otahuhu and Manurewa in the southern corridor. There was also a price penalty for using the slower buses – for example, the three-stage journey by GoWest bus from New Lynn to Britomart was $4.30 for a single trip, while the same journey by train was only $3.80.

This competition between bus and train could be partly explained by the poor location of the central rail station relative to employment and retail opportunities in the CBD – a situation that was even worse before the opening of the Britomart terminal.

Outside the Northern Busway, bus services were designed to avoid transfers: a multiplicity of indirect lines were used to link likely origins and destinations. At some locations, timetables referred to transfers and interchanges, but connections with trains were seldom well designed or encouraged. For example:

- *Bus–rail to and from the airport*. The only service that made a direct link between the rail line and the airport (#380) operated on 30-minute headways[5], while the Southern Line train stopped at Papatoetoe station every 15 minutes outside peak periods. This complementary pattern should have enabled effective transfers, but, in both directions, the timetabled arrival of the bus at the station was the same as the train departure. This guaranteed a 15-minute addition to the scheduled 52 minutes in-vehicle time for the trip from the domestic air terminal to Britomart. In peak periods, during which train frequencies were greater, there were some good bus–train connections, but these were given no special recognition in the bus timetable.
- *Manurewa station* was a designated 'interchange', but bus–train coordination was extremely poor for the #455 and #456 'feeder' bus lines. Bus services to the station were timetabled to arrive at the same time as the train departed and, for the reverse journey, to leave one minute before the train arrived.
- *Bus timetables in the south and west* encouraged users to transfer to other bus services rather than to the faster train. This was seen in the south at Papakura, and in the west at New Lynn.

Bus-bus coordination was managed slightly better than bus–train connections, but only where lines were operated by the same company. For example, timed transfers were available for a grouping of several lines at Botany Town Centre in the eastern suburbs away from the rail corridor. This coordination was important, as the typical frequency of suburban distributor buses was two per hour, or less.

Most bus services followed very indirect routes, which had a negative impact on patronage levels. Where the bus services followed more direct routes, such as the lines operating along Dominion Road in central Auckland, which largely followed the routes of the old tram services, patronage was significantly higher – more than could be attributed to the minimal differences in adjacent land use.

In addition to the bus and train services, a number of ferry services operated on different Auckland waterways. These carried around 8% of the total for all modes of public transport patronage in 2007/08 (ARTA 2008, p15[6]), compared with rail's share of 12%. Because of our research team's lack of familiarity with ferry operations, and the relatively low rate of growth in ferry patronage compared with rail, ferry services were not included in this analysis – however, customers wishing to combine a ferry trip with other public transport services also experienced problems of timetable coordination.

5 'Headway' is the time interval between services.

6 Patronage in this data included school bus passengers (around 2% of the total).

4.2.3 The Northern Busway

The Northern Busway offered a trunk service with weekday headways of around 5 minutes in the peak and 10 minutes in the inter-peak and early evening, although services were relatively sparse after 8.30pm. Travel time to the CBD was 30 to 40 minutes, depending on the degree of congestion on the city approaches.

The design of interchanges at busway stops was conducive to easy transfers, and the routes of some local bus lines had been altered to take advantage of the improved travel times offered by the Busway. However, other bus lines (such as #891 and #891X) ran in competition with the Busway, taking passengers all the way to the CBD, but at slower speeds.

4.2.4 Circulation within the CBD

The concentration of many lines within the central city was major source of delays, particularly as buses competed for street space with private cars and had little effective signal priority. Around Britomart, and along Queen St from the waterfront to the Town Hall, the complex layout of stops for different lines created confusion for passengers. There seemed to be little focus in bus route designs to facilitate the distribution of passengers from stations at Mt Eden and Boston Road to destinations in the southern end of the CBD.

4.2.5 Orbital routes

The LinkBus line around the CBD followed an indirect route and had a relatively slow speed because of competition with cars for road space, the midblock location of stops, and an absence of priority at traffic signals. However, its distinctive livery made it comprehensible to users, compared with the opaque routes and confusingly complex layout of stops common to other buses operating in the CBD, and users appeared to be willing to overlook those service defects.

4.2.6 Ticketing

There was a bewildering array of tickets available for travel on public transport in Auckland. Veolia issued one set of tickets solely for train travel, and nine separate sets of bus tickets were offered by the various private operators. Free transfers between services were generally limited to those run by a single operator. Almost all fares were based on distance, with up to eight fare stages, except for the Northern Busway, which offered time-based tickets. Most tickets were paper, although some ‘smart’ tickets were available – chiefly as means to store value for multiple trips on the services of a single operator.

4.3 Wellington

4.3.1 Institutions

As in Auckland, ‘commercial’ operations supplied a significant share (around 20%) of the public transport services, and took the following three forms:

- commercial services ‘peppered’ amongst contracted services on regular routes – including routes for which peak services (and associated fares) were commercial, while the public agency delivered the less-profitable off-peak services, and even some for which the commercial operation comprised only selected services during the morning peak
- commercial peak-only express services

- fully commercial routes (including the Airport Flyer).

As in Auckland, the public transport system had a common brand – Metlink information services, maintained by the Greater Wellington Regional Council (GW), which has largely maintained control over some important strategic directions for the regional public transport system. Compared with Auckland, Wellington's smaller scale simplified relations between GW and the eight local councils in the region, although problems of inter-agency coordination did add complexities for transport planners.

There were two large private bus operators and a number of small operators. The New Zealand government (through the New Zealand Railways Corporation) had recently taken ownership of the suburban rail operator Tranzmetro, formerly a subsidiary of Toll Holdings.

4.3.2 Service patterns

The published map for Wellington's public transport system revealed some sound elements of network planning in service patterns: trunk routes in the main travel corridors, with feeder services and 10 identified suburban interchanges.

4.3.3 Bus–rail competition on trunk routes

As in Auckland, bus services competed with rail on the trunk routes and, although the train services were generally much faster than the buses, this was not always the case.

For example, in the Hutt Valley corridor, the Airport Flyer and a number of other bus services, some operating peak-only schedules, directly competed with rail for passengers travelling to the Wellington CBD. However, the trip on the Airport Flyer was slower and more expensive than the trip by train: Upper Hutt to Wellington Station took 50 to 55 minutes by bus and the cash fare was $11.00; the corresponding train trip took 45 minutes (40 minutes for expresses) and was, at most, $8.00.

In the Porirua corridor, the train trip to the CBD (20 minutes express) was less than half the time taken by the #60 bus. However, the bus played a role in the wider network by providing a connection to Johnsonville – from Johnsonville to the CBD, the bus was faster than trains on the circuitous Johnsonville line (15 minutes on #60, compared with 21 minutes by train).

Many published timetables provided information about rail–bus connections, although these advertised transfers commonly involved waiting times of 10 minutes or more. These long waiting times could be a conscious response to problems with service reliability, but they tended to reinforce the preferences of commuters for the numerous 'peak-only' bus services.

4.3.4 Design of groups of local suburban bus lines

Suburban development in the Wellington region is typically located in relatively isolated valleys and along coastal strips. To serve these developments, local and feeder bus services in the two major corridors north of Wellington City were organised in groups. In the past, some of these groupings (eg in the Wainuiomata area and in Stokes Valley) had very convoluted route layouts with closely spaced stops, which led to long travel times. Compared with these historic layouts, the route patterns observed in this study were more direct and had fewer stops, but were not changed to the extent that GW planners had originally proposed. Current patterns were established as a compromise, brokered by regional councillors, between the planners and users of the old services.

Coverage for local bus lines was typically around 16 to 17 hours (from around 6.30am to 11.00 or 11.30pm) with off-peak frequencies of between 15 and 30 minutes, although there were some lines (eg #65 north of Porirua) that ceased operation in the early evening and had hourly off-peak headways.

Such lines offered relatively poor service but were nonetheless designated as 'full-service' lines on the Metlink network map. (To be considered less than 'full service', a line needed to operate less than hourly, Monday to Friday.)

4.3.5 Service planning

Regular reviews of routes and timetables had been held in order to adapt the service patterns to the changing needs of users. The outcomes of the 2008 review of services in the suburbs north and east of Johnsonville (described below) illustrated the standoff between planners in the public agencies and the operators of the private bus companies. The review was said to have resulted in 'More direct bus routes to and from Wellington at peak times, and new routes to make services easier to understand and use' (GW 2008), but the actual outcomes were not as much of an improvement as had been hoped.

The major changes were as follows:

- *Creation of new peak-only services*

  To the east of the Porirua Motorway, three lines would now leave from three distinct suburban termini in the peak period. These three lines would merge to follow a single route for most of the journey to the Wellington CBD. None of these lines would operate in the off-peak.

- *Reorganisation of off-peak services*

  Before the review, suburban destinations near Johnsonville were served in the off-peak period by two services with indirect routes – one of these travelled all the way to the CBD, and the other linked by a timed transfer (timetabled as a 5-minute wait). The review prompted the establishment of a single line (#52), originating in Johnsonville, which eliminated a 2km diversion but included 27 minutes of travel on suburban streets. In contrast, before the review, the direct peak service from Johnsonville (#56) ran on suburban streets for only 12 minutes.

These changes had been driven largely by the operators and only reluctantly accepted by the GW planners in return for other contract concessions relating to fare collection.

4.3.6 'Orbital' routes

There were no services linking the Hutt Valley to the Porirua corridor without transfers close to the city centre. This was partly because of the absence of road links, but that was not the whole story – previous attempts to provide such services appeared to have been erratic. The private company, NZ Bus, had conducted a short-lived trial of an orbital route from Lower Hutt to Karori, which was abandoned because of low patronage – but this could have been due to minimal publicity and unrealistic expectations.[7]

4.3.7 Circulation within the CBD

There were more than 20 bus and trolley lines serving Wellington's inner southern and western suburbs. Almost all these lines, together with the growing number of bus lines from the northern corridors, shared the crowded streets of the CBD between Wellington Station and Courtney Place. The problems that this congestion caused regarding efficient operations and public understanding of the system were well understood by local planners.

7 In February 2009, NZ Bus managers told researchers in Wellington that they were surprised at the low numbers of passengers travelling the full length of the line.

4.3.8 Ticketing

Each service operator issued a variety of different tickets. Within single trips, many transfers required an additional ticket. Within the contiguous suburban development of Greater Wellington, there were 10 fare zones, with a further four zones for travel to regional centres.

Day-trip tickets, which allowed multiple journeys and transfers, were available separately for bus and train travel. A combined ticket was also available, but the price was the same as that for bus and train day passes that were purchased singly.

4.4 Christchurch

4.4.1 Institutions

Since 1998, directions for planning have been set by a Public Transport Strategy that was prepared jointly by the regional council, Environment Canterbury (ECan), and the Christchurch City Council (CCC), with input from an advisory committee comprising bus operators, user representatives and other interest groups.

The Metro unifying brand and bus livery was introduced in 2000. Under that logo, ECan has contracted services from three bus operators, the largest being Red Bus Ltd, which evolved from the Christchurch Transport Board and remained under the ownership of the City Council.

The only 'commercial' services in this area were the two lines operating to the airport, which were made viable by charging higher cash fares.

4.4.2 'Core' and 'community' services

There were nine core lines in Christchurch's bus-based public transport system. These services had minimum headways of 15 minutes during the day and 30 minutes in the evenings and weekends. In addition, a free central-city shuttle ran along a 1.5km stretch of the main north-south arterial (Colombo St), with turning circles to take in the Casino and the Christchurch Institute of Technology. This service was operated by Red Bus and funded by the City Council.

There were two cross-town lines, one being a full orbital, and the other (Metrostar) taking an east-west route passing through the inner northern suburbs. The 'Orbiter' operated at 10-minute headways between 6.00am and 7.00pm on weekdays, and half-hourly from 9.00pm, with the last bus terminating at 12.45am. It took a circular route about 3–5km from the central city, with identified transfer points at six suburban shopping centres. Since the full circle route was put in place in 2000, planners have reported a level of transfers exceeding their initial expectations.

The other 'core' lines were radial. Five of these turned around in the central city and two operated in pendulum fashion (ie the routes started at one suburban terminus and ran through the CBD to another suburban terminus). Thus, nine radial corridors had 'core' services. The routes taken by these lines were, for the most part, reasonably direct – at least in the middle and inner suburbs. The exception was #60, serving the suburban Burwood Hospital from New Brighton, which took a rather indirect route to the central city. (A recent service review has foreshadowed changes to make this route more direct.)

Travel speeds on the radial routes were typically around 24kph in the peak and 30kph at night (using the example of the western leg of line #5). The Orbiter had an average speed of around 21kph.

The remaining lines, called 'community services', operated at frequencies of 20–60 minutes during weekdays, and less often in the evenings and at weekends. These services operated on indirect, often

overlapping, radial routes in the gaps between the core lines. There were 26 community lines, (12 being through-routed services), and there were more planned for late 2009, to create pendulum services.

In addition, six shuttle services linked satellite towns beyond the Christchurch urban boundary to suburban centres, operating, at best, at hourly frequencies.

4.4.3 Timetables on common route sections

Most lines shared a common route section with another line: there were as many as nine lines on the western approach to the central city along Riccarton Ave.

There was some coordination of timetables on common sections. For example, three lines (#10, #66 and #67) shared a common section at the south end of Colombo St in the southern suburbs. Each of these lines operated only hourly in the inter-peak period, but timetables were coordinated to provide regular 20-minute headways on the common section. Unfortunately, this coordinated scheduling broke down further north in Colombo St, where a further four lines merged. North of Brougham St, 14 services per hour ran in the inter-peak. However, in any one hour, passengers faced two gaps of 14 minutes between city-bound buses, and there were two six-minute periods during which five buses arrived.

4.4.4 Circulation within the CBD

A total of 47 radial routes (served by 33 lines) converged on the central city. Circulation patterns in the central city were complex. For example, non-pendulum lines turned around via circuits of city blocks on the ‘far’ side of the CBD. The planners were intending to simplify this by creating more through-routed lines. However, with only one exception, all city-bound lines passed through the City Bus Exchange. About half these lines used roadside stops in Colombo St; the others used platforms inside the exchange. Delays in entering and leaving the exchange added to travel times, but the impact on passengers appeared to be ameliorated to some extent by the amenity of the bus exchange, which featured airport-like seating and TV monitors, and successfully separated waiting passengers from the noise and fumes of the buses.

4.4.5 Ticketing

Three fare zones covered the Greater Christchurch region. Most services operating inside Christchurch City were in Zone 1.

Substantial discounts and transfer opportunities were available for passengers who used the ‘smart’ MetroCard rather than cash. Within Zone 1, a single trip with a cash fare cost $2.80 and included one free transfer within 2 hours; with a MetroCard, the single trip fare was only $2.10 and included unlimited free transfers within 2 hours. All-day travel with unlimited transfers cost $4.20 using a MetroCard. A more expensive ‘all-day’ cash option ($10.00) was available for travel only on routes operated by Red Bus, which covered about 75% of Zone 1 services, but did not operate on the Orbiter.

5 The potential for improved network planning in New Zealand cities

5.1 Introduction

In section 2, we identified the elements of public transport planning that are required to create the high-quality, transfer-based networks that could enable an increase in public transport trip-making at an affordable cost to operators. It is clear from the observations made in section 4 that the design of some key aspects of public transport services in Auckland, Wellington and Christchurch were based on a different planning rationale from that which underpins the 'network' approach.

This chapter explores some specific opportunities for changes to public transport services in New Zealand cities that would follow from the adoption of the network-planning rationale. It provides, in effect, a checklist of the key requirements for networked public transport in New Zealand cities, and should be read in conjunction with the *HiTrans best practice guide* (2005), which further elaborates the underlying principles.

Although this project was not intended to provide detailed operational plans, we hope it provides sufficient direction for the appropriate agencies to take this forward. This has already occurred in Wellington, where ideas raised in project workshops in February 2009 for the reorganisation of bus and trolley lines in the heart of the CBD's commercial and retail precinct (the so-called 'Golden Mile' along Lambton Quay) have been referred to consultants as options for operational changes.

5.2 Institutions and public processes

The institutional environment for successful implementation of 'networked' public transport requires:

- a public agency to plan the network across the whole city region
- understanding that the appropriate place for private-sector competition in the provision of public transport services is not in a contest between operators for customers on the busiest routes, but in producing best-value tenders for the delivery of part, or all, of a publicly planned system
- well-designed public education and consultation programmes to effectively manage change
- a fare system that is simple to understand and that avoids the imposition of penalties for transfers – the technology used to sell tickets should be secondary to the design of the system.

At the time of writing, the institutions that coordinated public transport services in Auckland, Wellington and Christchurch were chiefly part of regional governments, which have the skills and structures necessary to plan networked public transport services. However, in Auckland and Wellington, a new relationship would be required between the regional transport planning agency and the private operators, based on recognition of the mutual benefits that would flow from the increased patronage that could be achieved through a planned network.

'Gross-cost' contracts with private operators, where farebox revenues are kept by the tendering authority, would be appropriate for the delivery of networked public transport – we would be in agreement with their adoption under existing or reformed procurement legislation.

New public processes would be required to build community support for reorganisation of existing public transport services into a functional network. In both Wellington and Auckland, recent upgrades to rail systems have provided a useful context into which operational changes could be presented to the community. The composition of Christchurch's strategic advisory committee (the Passenger Transport Advisory Group) could provide a good model for a framework within which these public consultations could be organised.

In the renegotiation of the relationships between public and private institutions that must accompany a shift to the network approach to public transport service delivery, it would be essential, in both Auckland and Wellington, to create a fare system that:

- provides a mechanism for cross-subsidies for lower-patronised services that supply important network connectivity
- removes the financial penalty for making transfers between lines and modes
- reduces the numbers of zones, to make the system easier to understand and market.

5.3 Network structure

The key elements in the design of an effective network structure are:

- use of the 'ready-made' approach – ie a simple and stable network of lines throughout the day with frequency and vehicle sizes adjusted to match capacity requirements in the most- and least-busy times
- mode choice for different lines in the network based on required capacity, comfort and speed
- careful consideration of locations for suburban interchanges, based on predicted travel patterns and efficient vehicle operations.

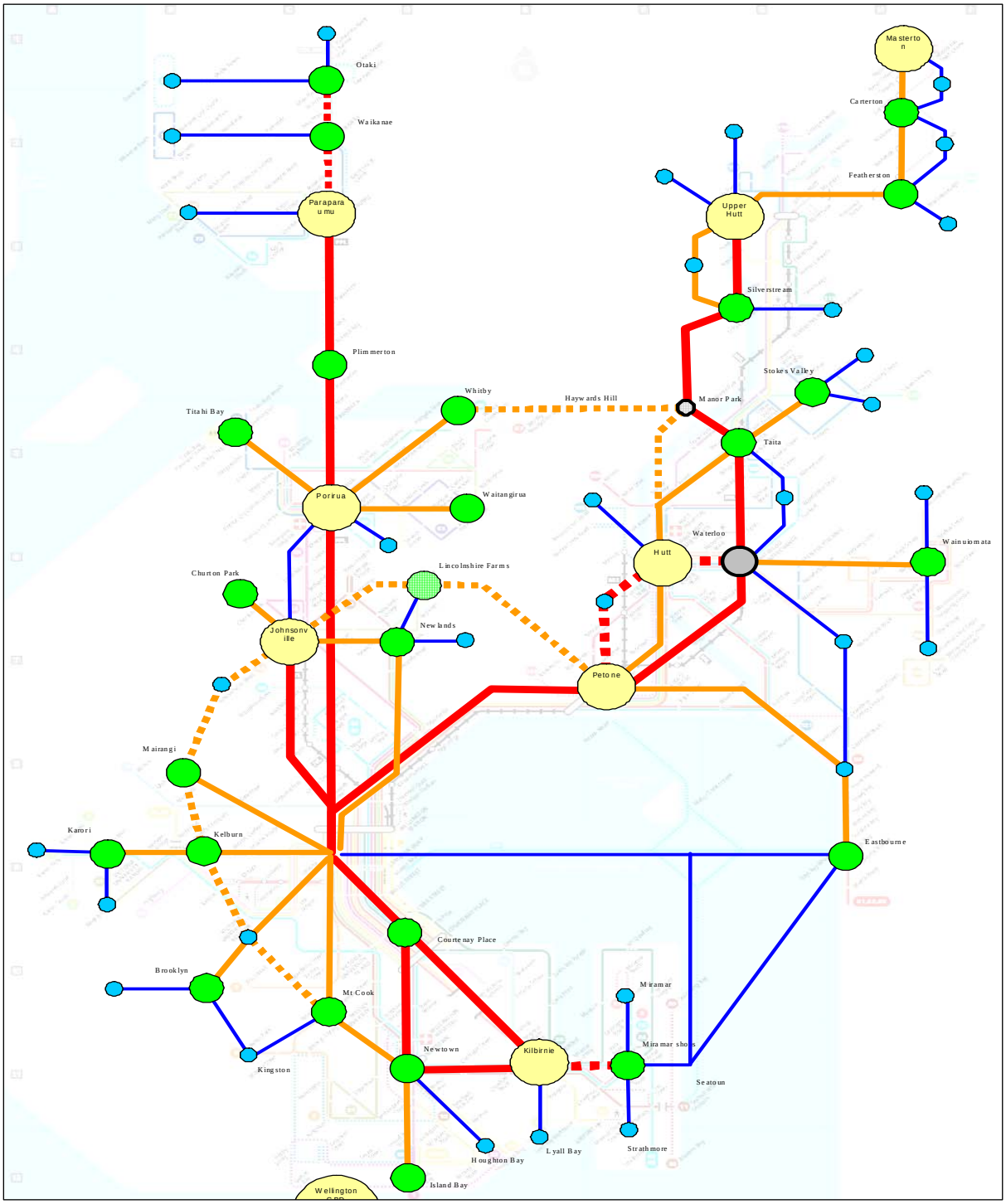
From our study, it was clear that the 'tailor-made' approach has dominated the design of public transport in New Zealand cities, particularly in Auckland and Wellington. This approach (in contrast to the 'ready-made' approach that we have argued is more effective) is characterised by changing patterns of services for different users at different times of the day. Typically, commuters are offered a plethora of express bus services, running only a few trips each day in peak times, from all points of the compass. Separate services, with different routes, are provided at night and for local 'community' trips.

This approach (in Auckland especially) often puts bus services in competition with the train, even though travel times by bus are much slower because of traffic congestion. So, for example, even though works were being done to upgrade the New Lynn bus–train interchange in the western suburbs of Auckland, the full potential of such expenditure would not be achieved without reconfiguring bus services to act as feeders, with the train providing fast services over longer distances.

As discussed in section 3, the alternative 'network' approach to service design could lead to greater efficiencies in the deployment of vehicles and drivers by increasing the rate of boardings per service-km.

Decisions about the location of key suburban interchanges for a public transport network would largely follow from land-use planning decisions, although it would be necessary to take an iterative approach, recognising that decisions about the location of high-quality public transport routes and interchanges would drive locational choices for developers. The *HiTrans best practice guide* (Nielson 2005, p41) gives a useful outline of the basic steps in such a process. A theoretical strategic public transport network for Wellington is illustrated in figure 5.1.

Figure 5.1 A theoretical strategic network for Wellington



A similar strategic network, shown earlier in figure 3.4 (section 3), was used by planners in Zurich as the basis for their successful route layout.

5.4 Network operations

Once decisions have been made about the basic structure for the network, the details of the operations of each component line would need to be considered in a way that allowed stable and reliable performance. Efficient and effective operation of the individual lines in a network would depend on a number of interrelated factors:

- simplicity and directness
- speed and reliability
- frequency
- attention to location of stops and access to services
- marketing to provide good information for first-time and occasional users.

These factors are explored in detail in chapter 3 of the European *HiTrans best practice guide* (Nielson 2005), and specific comments about their use in the New Zealand cities are made below. Issues such as comfort, cleanliness and safety for passengers are also important, but fall into a slightly different category of operational responsibility to the 'network' factors described here.

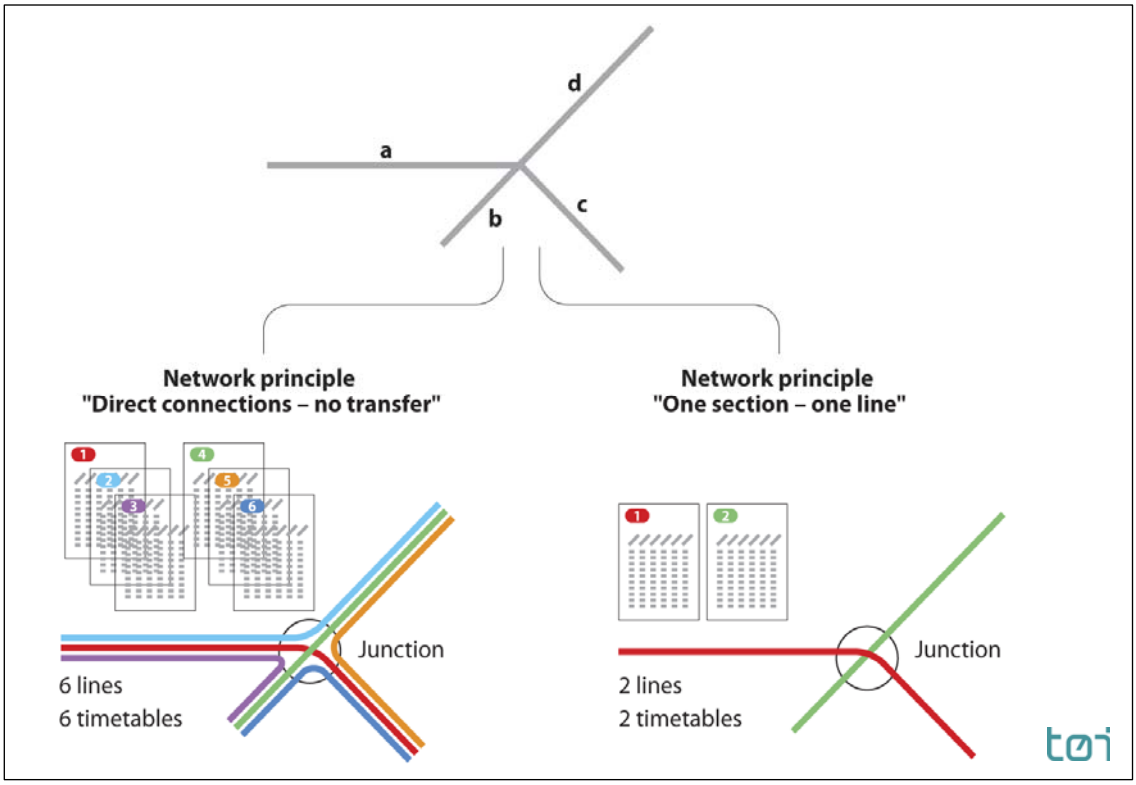
Simplicity for both users and operators requires:

- coverage of any section of the network to be organised on the principle of 'one section – one line' (see figure 5.2 for the effect of the alternative organising principle of 'direct connections – no transfers')
- avoiding deviations in the physical routes chosen for both orbital and radial lines
- providing pendulum lines through key activity centres and interchanges (see figure 5.3 for details of the effects of this).

5.4.1 A simple and direct network of lines

Reflecting the 'tailor-made' design approach, most bus services in the New Zealand cities, even those in high-volume travel corridors, have followed indirect routes – even though, in many cases, a much more direct route could have been taken while still keeping the great majority of potential passengers within a 400m walking catchment. Even on Auckland's north shore, with its complex topography and poor road connectivity, practical redesigns of bus routes to create more direct services could be made.

Figure 5.2 The HiTrans 'one section – one line' approach (Nielsen 2005, p107)



As can be seen in figure 5.2, the 'direct connections – no transfers' approach requires three times as many lines and timetables to achieve the same level of connectivity for passengers.

In Wellington, recent service reviews have retained indirect suburban services in the off-peak period and continued service duplication inside a single walking catchment.

In all the New Zealand cities, there was considerable duplication of bus lines serving the major travel corridors. This meant that both on the approaches to the CBD and within the CBD itself, buses were operating at very short headways that exceeded practical capacity limits and created much operational inefficiency.

5.4.1.1 Wellington

The issue of an appropriate network design to improve the efficiency and attractiveness of services in central Wellington was raised in project workshops in February 2009. Several network design changes were considered in order to achieve workable headways of around two minutes (30 buses per hour) in Lambton Quay – the main bus route in the Wellington CBD. These changes included the possibility of terminating some lines at a suburban interchange in Kilbirnie, and creating a second public transport corridor through the CBD along the waterfront. Under this scenario, it could also be possible to serve Lambton Quay solely with trolley buses, thereby reducing noise and emissions in this busy and largely pedestrian precinct.

Another issue discussed in Wellington was the appropriate role for express services in a simplified network. On the rail system, regular scheduling of long-distance express services would be entirely consistent with a simplified network. An express, followed closely by an 'all-stops' service, could effectively cater for travel to both major and intermediate destinations. The key would be to establish a simple set of stopping patterns that users could easily understand and remember.

5.4.1.2 Auckland

In Auckland, there is an urgent need for effective, fast bus movement along Queen St and parallel streets, to eliminate the historic patterns of competition between bus and rail for commuter travel.

Like Auckland, Vancouver has a limited rail system and a central employment, retail and education core that spreads over a considerable distance. Vancouver dealt with this problem by using trunk bus corridors to extend the coverage of the rail system across the city centre. Major routes (including the #99 B-line) were connected to key Skytrain stations, ferrying passengers to parts of the central city not directly served by rail. Some of these routes, notably #99, will eventually be replaced by rail lines. (Wellington has a similar pattern, with the main bus terminal adjacent to the rail station.)

Until a few years ago, Auckland's rail system carried such a small proportion of all city travel that there probably seemed to be little need for a Vancouver-style approach. The opening of the Britomart terminal in 2003 brought rail services closer to at least the southern part of the CBD. However, passengers seeking to access parts of the central city that are remote from Britomart still needed better connections – their absence was a main reason for providing bus services that paralleled rail operations, as outlined in the earlier discussion.

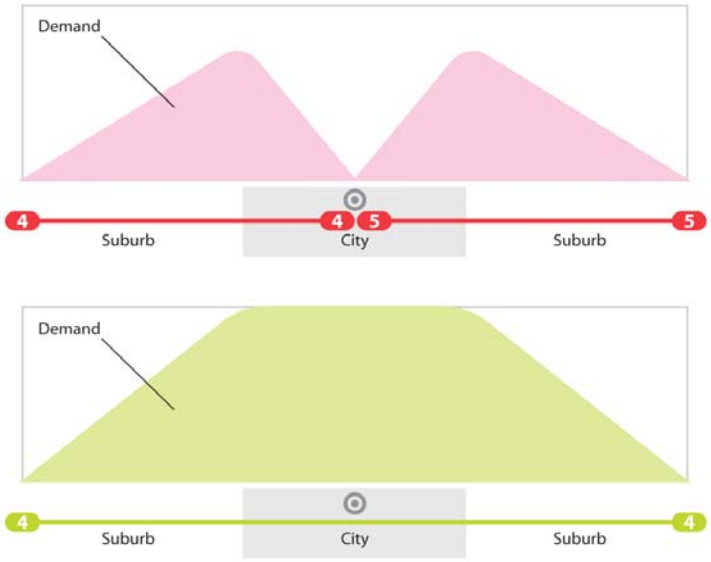
Long-term plans to extend the rail system through a tunnel under Auckland's CBD would resolve this, but in the meantime, improvements to the bus services are required. The 'Central Connector' project, under construction at the time of writing, was initially advanced as a 'rapid-transit' solution instead of the rail tunnel. However, this project could entrench rail–bus competition, rather than allow a network approach, as it would be used mainly by bus services that paralleled the southern and eastern rail lines.

However, the Connector could also be used as a catalyst to reconfigure bus services to collect passengers from stations like Newmarket, Boston Road and/or Mount Eden, and distribute them to the central and southern parts of the CBD. This would require a simplification of route structures, numbering and liveries to create something closer to the dense trunk corridors of Vancouver or Schaffhausen (see section 3), or a more direct, frequent version of the successful LinkBus service. Additional works at interchange stations would ease intermodal transfers, while the proposed multimodal fare system would also need to be in place.

5.4.1.3 Christchurch

In Christchurch, considerable investment was made in a central-city terminal that, while popular with users, created inefficiencies in bus operations. The Christchurch system has some pendulum-style lines, but this aspect of network design could be strengthened, following the model of the Schaffhausen experience described below.

Figure 5.3 Benefits of the pendulum approach (Nielsen 2005, p121)



Results

- New travel opportunities
- More efficient operations
- Improved use of capacity
- Less traffic space in the city centre
- Fewer buses
- Fewer lines
- More passengers

Requirements

- Time adjustments at end terminals
- New routines for the drivers
- Reliable speed

Using pendulum routes reduces the need for large terminals in areas with high property values, and better utilises capacity on the highest-demand sections of the line. As described in figure 5.3, the ability to provide a direct service to destinations on the far side of an activity centre taps into an obvious demand and helps to increase loadings on vehicles in the most space-sensitive portions of a route.

Since trams were removed from Schaffhausen in the 1960s, local public transport has been provided by buses and trolley-buses, but offering tram-like services. Six full-time pendulum routes have operated through the city centre to connect opposite sides of the town, at 10-minute intervals, from around 5.30am to 8.00pm on weekdays and Saturdays, and on Sunday afternoons (20-minute intervals at other times). Articulated vehicles have been used on the three busiest routes, and midibuses on the quietest route. Regular bus services have been finishing at around 12.30am, but a limited 'night network', with services every 30 minutes until 2.00am, has operated on Fridays and Saturdays.

All buses have stopped outside Schaffhausen's main railway station in the city centre, waiting there for two or three minutes while passengers transfer. Every 10 minutes, a dozen buses have converged on the station, lining up on each side of the street outside the entrance, before moving off, one after the other. Each convoy left at exactly 10, 20, 30 (and so on) minutes past the hour. The two alternating states of 'no buses' and 'all buses' in the street outside the railway station are shown in figures 5.4 and 5.5. Note the absence of purpose-built bus shelters. Since these pictures were taken, car access has been restricted, with the street becoming a pedestrian plaza for most of the day.

Figure 5.4 At most times, the street outside the Schaffhausen railway station is empty of buses. (Photo: Gustav Nielsen)

Figure 5.5 Six times in each hour, 12 buses arrive at the same time and depart at the same time. (Photo: Gustav Nielsen)

With services this frequent, there has been no need to specifically coordinate the bus and train schedules, although the last night-buses have been timed to meet the 1:00am 'S-Bahn' train from Zurich. Transfers have been free, and the city's fares have been integrated with those of the regional buses serving the 30,000 residents of rural parts of Schaffhausen Canton. Heavily discounted season tickets (or 'periodicals') have been available, with a monthly ticket costing only twice as much as a weekly ticket. Despite this, cost-recovery rates have been respectable, assisted by strong off-peak

loads and full-fare-paying custom. Fare revenues have covered just over half of costs, with a further 10% of the costs covered by a levy on city parking, and the remainder shared between the two municipalities and the cantonal government (Verkehrsbetriebe Schaffhausen 2008, p12).

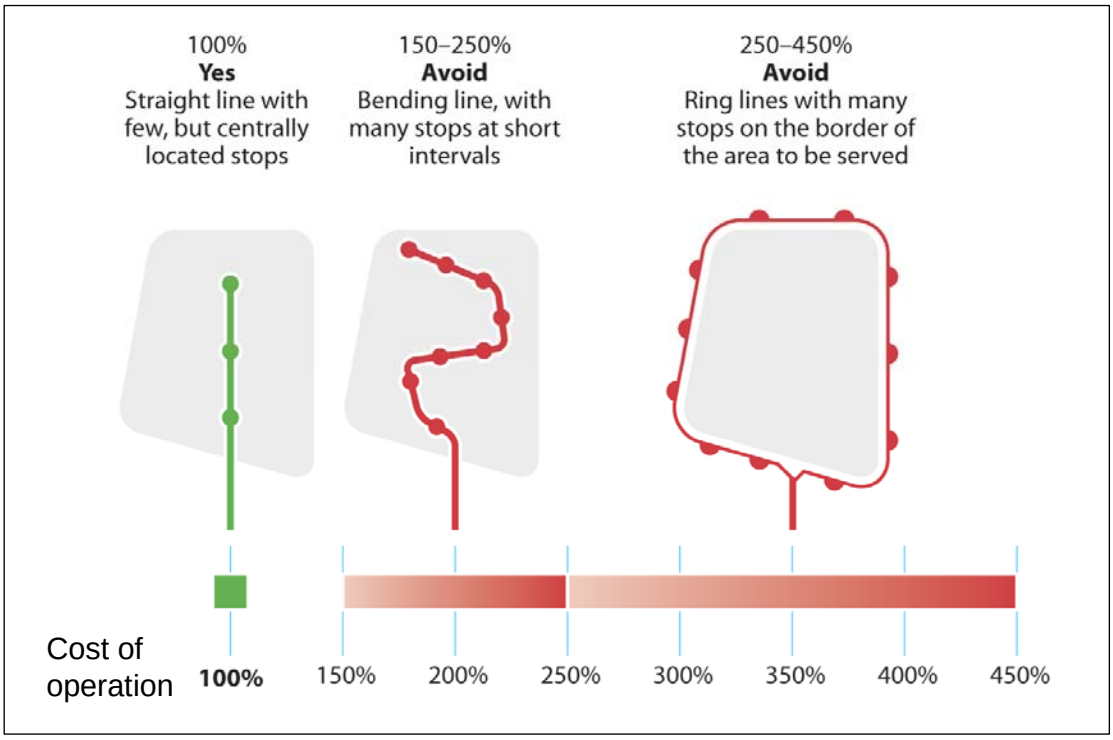
This service concept could be applied to radial routes in Christchurch, complementing the strong performance of the circumferential Orbiter. If stronger pendulum routes improved Christchurch's cross-inner-city public transport, its dedicated central-city shuttle service might not be needed. A series of clear, high-frequency pendulum routes, 'branded' with names like the Green, Orange and Silver routes, have been successfully operating in Wellington for some time. Christchurch, with its easier terrain and lower levels of congestion, should be particularly suitable for this concept, although the practicality and desirability of Schaffhausen-style 'pulsing' would require further study.

Cross-city pendulum routes could offer a number of advantages, including:

- linking destinations on different sides of the CBD
- providing travel options within the CBD – an important issue in Christchurch, where the city centre spreads over a considerable distance
- eliminating duplication, producing savings in resources (buses and drivers), which could be redeployed to intensify service frequencies
- supplementing the dedicated central-city shuttle, which runs roughly north–south, by providing links for travel in other directions – or even replacing the shuttle altogether, allowing further redeployment of resources.

A further issue for consideration in all the New Zealand cities would be the location of stops at the suburban end of public transport lines (for a detailed discussion of this issue, see Nielsen 2005, pp124–128). International experience has suggested that spacings of around 600m are an appropriate compromise between acceptable walking times and efficient operating speeds. Nielsen also noted that in private conversations, European operators reported that passengers would walk further than this to frequent and reliable bus services, which points to obvious efficiency gains for operators. This is an issue that warrants further research.

Figure 5.6 Operational efficiencies from direct routes within suburban developments (Nielsen 2005, p133)



Nielsen also discussed the implications of indirect routes for bus services through suburban developments, arguing that indirect services created considerable inefficiencies, as shown in figure 5.6 (pp133–134). He said that indirect services were harder for users to understand and were difficult to market.

5.4.2 Speed and reliability

Speed and reliability require that:

- average travel speeds are as fast as possible to achieve comparable, or faster, door-to-door travel times than can be achieved by car
- on-road signals and traffic-lane priorities allow buses to reliably meet connections at interchanges
- vehicles stop only as required to pick up and drop off passengers.

Upgrades to rail systems in both Auckland and Wellington would offer opportunities to increase travel speeds, and also provide a valuable context for building public understanding and support for the wider changes associated with a move to a networked public transport system.

Improvements to travel times for bus services would be harder to achieve than for rail travel times, as they would require some restrictions, both perceived and real, on the priority given to private cars at traffic signals, and in the availability of road space. Obviously, such changes could be strongly contested by drivers and by road engineers at many levels within various traffic management agencies,

and would require a reversal of a longstanding political consensus. To achieve this change, public transport agencies and elected officials would need to actively engage in internal and public processes.

The network approach would strengthen the arguments for providing on-road priority for public transport. It would be much easier to argue that a particular bus should be given signal priority at an intersection to help it reliably meet a crucial network connection, than if the same bus was following an existing timetable that, to all practical purposes, operated independently from the rest of the system.

5.4.3 Frequency and appropriate service density in weaker markets

Service density requires:

- optimal 'forget-the-timetable' headways (10 minutes or less) in key travel corridors
- integrated timetables outside high-frequency areas
- demand-responsive services to supplement scheduled services.

Experience from the benchmark cities suggested that political and community support for public transport would grow with increasing patronage. As success could be demonstrated, more measures to give priority to public transport vehicles would be professionally and politically acceptable.

In many travel corridors in all three New Zealand cities, frequencies in off-peak periods have been well below the 10-minute interval that the literature suggests is required to operate a viable multidirectional alternative to the car without coordinated timetables. The marginal costs of increased off-peak frequencies would typically be much lower than the costs associated with increased peak frequencies, because sufficient vehicles would be available from the existing fleet. This lower cost and the likely returns from increased fare revenue would mean that increasing off-peak frequencies offered better value for money than increasing peak frequencies

There were many examples, especially in Auckland, of adjacent bus and train services that operated on 'clock face' timetables (ie operating at the same times in each hour) and with matching headways. These services could have easily provided very efficient transfers at key parts of a network (eg for the trip between the airport and the CBD), but timetables had not been prepared in ways to minimise waiting times.

In these examples, the failure to adjust bus timetables to create an attractive transfer, even though there have been no practical impediments to doing so, reflected a number of interrelated problems:

- an absence of consensus on the design rationale for the public transport system
- a lack of clear accountability of the public agency for design of a network
- the relative autonomy of the private operators.

5.4.4 Location and access to stops

Location of stops:

- To optimise travel speeds without creating excessive walking times, stop locations should be carefully planned to minimise the number of stops, and to ensure their optimal location in relation to major trip attractors, intersecting lines and pedestrian accessways.
- Stops located in car-free precincts close to important destinations give public transport a significant competitive advantage.

Access to stops:

- While 'park-and-ride' will remain an essential means of access to major public transport lines in outer suburban areas, there are clear limits to this option because parking is a low-value and alienating use of premium land. To cater for long-term growth in patronage, passengers should be able to walk, cycle, or use feeder bus services to reach public transport 'trunk' services.
- In a well-designed interchange, walking distances between services should be very short – preferably no more than 10 metres.

Any proposal to change the spacing of bus stops on existing routes would inevitably lead to a negative reaction from existing users, so this should be part of a wider package of measures transparently offering a substantial improvement in public transport service quality.

The recent experience in establishing 'park-and-ride' facilities on the Auckland Northern Busway provided a good illustration of the limitations of this means of access to public transport – most carparks were filled with cars well before the capacity of the buses was reached. Also, even when Busway stops were located on freeway slip lanes, a long way from any other urban activity, a significant number of passengers still arrived on foot.

From our brief observations during this project, the bus interchanges on the Northern Busway appeared to be designed to enable easy transfers, with only short walking distances and adequate directional signage.

5.4.5 Marketing the network

- A simple line structure makes it easy to understand, market and use public transport.
- Information in maps, on-line materials, vehicle livery and on-board displays should reinforce public understanding of the line structure and transfer opportunities.

As discussed earlier, the unique information and branding associated with Auckland's Link Bus inner-city orbital line appeared to be a significant factor in its relative success. Information and marketing were also probably important factors in the positive record achieved by the Christchurch Orbiter and Metrostar.

In general, the highest priority should be given to bus livery and signage that reinforces public understanding of the bus route and its place in the overall public transport network. We noticed that

advertising that simply aimed to bring the operators a small financial gain could entirely obscure the fact that a particular bus was part of the city fleet.

An example of combining useful public transport information with marketing in Christchurch would be the provision of a schematic map of the core radial and orbital bus routes. This map could easily be updated and expanded as other bus routes were re-designed and upgraded as part of a network-planning exercise.

6 The policy environment for network planning

There is potential for the improvements to network planning for public transport in New Zealand cities to be enhanced by supportive policies and practices across the whole transport and land-use planning system. This chapter discusses the current transport policy environments in Auckland, Wellington and Christchurch.

6.1 Land-use planning and public transport network planning

In Auckland, the relationship between planning decisions and the public transport network has been captured in three main documents: the Auckland Urban Design Framework (ACC 2007), the Auckland Growth Management Strategy (ACC 2003) and its evaluation in *Growing smarter* (ACC 2007).

The Auckland Growth Management Strategy stressed the value of building a compact city, with growth focused on increasing the density of development around town centres to support passenger transport services, which in turn would support a growing population.

This was echoed in the Auckland Urban Design Framework, which saw urban design's main contribution to sustainability as promoting higher-density, quality, compact, mixed-use communities 'served by better public transport, which will reduce the need to travel long distances' (p7). Two urban design objectives in the Framework stressed the relationship between land use and public transport:

- Objective 2.1 sought to promote increased density and intensity of land use in and around urban centres 'and along major public transportation corridors' (p17).
- Objective 3.1 advocated improvements in public transport provision to 'improve connections and choice, and help to regain public space' (p19).

However, the evaluation of the Auckland Growth Management Strategy noted that 'the opportunities to demonstrate high-quality urban design and sustainable building, to support key centres, and to provide enhanced community access (by foot or public transport) remain a challenge' (p97).

In Wellington, GW's Regional Strategy has provided land-use planning guidance and coordination at the regional level and below, with the Strategy being given effect through the Regional Policy Statement and Regional Land Transport Strategy. Greater Wellington has a long history of integrating transport and land use, with its linear development corridors following rail lines. The 2009 Proposed Regional Policy Statement for the Wellington region sought to reinforce this pattern and restrain scattered development.

Wellington City Council's 2006 Urban Development Strategy aimed to contain urban development within the established edges of the city, to minimise transport distances and make public transport more viable by providing sufficient people and activities to support public transport (p7).

The 2008 Canterbury Regional Land Transport Strategy (ECan 2008) supported the provision of new housing primarily within, or adjacent to, existing urban areas that were highly accessible by public transport, cycling or walking (p48). The document identified higher-density housing as providing more potential for increased patronage and therefore reduced service costs, meaning frequency could be improved, making public transport services more attractive. The strategy aimed to 'future proof' subdivisions by making them supportive of public transport (p109). Likewise, the 2007 Greater

Christchurch Urban Development Strategy and Action Plan (CCC 2007) sought to integrate land-use development with transport planning, to minimise the need to travel and to support sustainable travel such as public transport (p118).

Across the three cities, it could be concluded that regional land-use planning has increasingly recognised the need to promote transit-supportive urban forms, in particular by discouraging scattered and very low-density development. Such policies would make it easier to upgrade public transport through network planning.

6.2 Restraints on car access to the CBD: parking, environment for pedestrians

According to the 2005 Auckland City District Plan – Central Area section:

- long-term parking within the CBD would be constrained at existing levels, to keep traffic volumes within the capacity of the arterial road network feeding the central area
- privately supplied short-stay parking would be encouraged in appropriate Central Area locations
- further tightening of constraints on long-stay parking would only take place within the context of a regional parking policy and significant passenger transport improvements (Auckland City – Central Area Parking Policy 1999).

However, the Auckland City Council also aimed to provide high-quality walking connections to and between destinations within the CBD, including passenger transport stops and stations. Conflicts between pedestrians and vehicles would be removed by infrastructure such as overbridges, and by exploring opportunities to provide pedestrian links between the CBD and the surrounding suburbs (Auckland City District Plan – Central Area Access Strategy 1999).

In Wellington, the City Council's 2007 Parking Policy noted that the city had a high level of provision for parking, when compared with other cities of similar size (p2), but claimed to have limited influence on the total parking system because most of the off-street parking was not owned or managed by the Council. However, the Council stated that demand for parking should be influenced by facilitating 'sustainable transport solutions, such as public transport, walking and cycling' (p6). In this context, the so-called 'Golden Mile' along Lambton Quay could be a corridor for sustainable transport that would support its place as the city's key retail and commercial sector (p10).

The 2003 Christchurch Parking Strategy (CCC 2003) made it clear that parking should be considered within the broad context of providing a sustainable and safe transport system for the city (p9). In particular, Policy 4H aimed to ensure that parking did not adversely affect cycling or pedestrian activity, and that cyclists' and pedestrians' needs for road space were given priority over on-street parking (p11). Policy 4I aimed to ensure that the public transport system had priority over on-street parking regarding road space, and that parking spaces could be removed to ensure safe and efficient access for buses and taxis (p11).

In addition, the 2008 Christchurch Sustainable Energy Strategy proposed to use the precedent set by the Swedish city, Malmo, to support the use of fuel-efficient vehicles (eg hybrid and electric cars) by providing free parking spaces for them around the city.

In general, the parking policies for the three New Zealand cities have been less supportive of public transport than policies relating to regional land use and population density. Although there have been tentative suggestions of limits on long-stay parking, all three cities have continued to encourage the

expansion of short-stay parking, on the assumption that public transport was only really competitive for peak-period work trips. This view has underestimated the critical role that high-quality, networked public transport could play in securing the economic vitality of city centres, by transporting shoppers and visitors, not just workers.

6.3 Processes for assessment under development planning laws

The 2007 national Integrated Approach to Planning (IAP) noted that separated funding systems for public transport and infrastructure did not always promote integration (p5). Land-use planning and urban design could be used to facilitate easy access to public transport, walking and cycling. This would require:

- strong national and regional transport and land-use support
- implementation by district councils at the time of development
- ongoing support and management by regional councils, in the form of interagency agreements such as long-term council community plans (p18).

The IAP concluded that a 'national vision ... for integrated land use and transport is needed' (p28), such as a national policy statement to provide guidance, strengthen responses and reduce bad practice. The IAP also argued that this national vision would require a leadership role from both the Ministry for the Environment and the Ministry of Transport (p28). Furthermore, it suggested that regional councils would need to deal with cross-boundary issues in a more effective manner because 'individual cities are too small to properly integrate transport and land use' (p29). It noted that there was no monitoring, that no performance indicators existed to determine whether goals and targets were being met, and there was little enforcement or use of rewards for good practice (p29).

ARTA's 2007 *Guidance for achieving multi-modal developments* suggested that:

> *For any development that is located where significant public transport infrastructure and routes is or will be established, it is expected that the public transport mode share will be higher than the regional average, particularly during peak commuter periods* (p58).

While the process of making integrated assessments is still in its infancy, we believe that it has the potential to work in favour of improved public transport planning and provision.

6.4 Responses to patronage growth related to petrol price rises

According to the Ministry for the Environment, the recent rise in transport fuel prices peaked in July 2008 and led to the following drop in total vehicle kilometres travelled (VKT), reductions in traffic volumes, and changes in use of public transport:

- In Auckland, average rail patronage for the 12 months to July 2008 increased by 20%. Train passenger numbers in July 2008 were 32% higher than in July 2007.
- Average boardings for Auckland buses increased by 3.5% in the 12 months to July 2008. The opening of the Northern Busway in February 2008 encouraged significant numbers of people to switch to public transport, which was the main factor responsible for a 6% drop in traffic volume on the Auckland Harbour Bridge in 2008.

- In Wellington, train patronage increased by 3.4% in the 12 months to June 2008, and bus patronage increased by 0.7%.
- National traffic volumes were down by 7.5% in August 2008 compared with the previous year.
- Nationally, there was a 4% growth in public transport boardings for the year to June 2008 compared with the previous year. (http://www.mfe.govt.nz/environmental-reporting/transport/vehicle-km-travelled/total-vkt/case-study.html)

In 2008, an ARTA media release (20 August) stated that:

> *While we welcome the increase in patronage and had planned for growth, the additional demand we are now seeing due to petrol price increases has meant some operational challenges for us and our operator Veolia.*

Since then, ARTA's monthly business reports have continued to report increased patronage eg 20.6% (830,747 boardings) higher in March 2009 than in March 2008 (ARTA 2009).

6.5 Current priorities

The 2008 New Zealand Transport Strategy had a goal of increasing the use of public transport to 7% of all trips by 2040, from 111 million boardings in 2006/7 to more than 525 million boardings by 2040 (p54). The Strategy also suggested that the effects of congestion on Auckland's economic potential were costing the national economy $750–$900 million per annum. It held that a focus on continuing to improve public transport (with developments such as the Northern Busway and upgrading the metropolitan rail network, including electrification) and managing travel demand would 'help address congestion and contribute to improving the competitiveness of Auckland as an international hub and world-class city' (p57).

Evidence was cited that the agglomeration effects of concentrated economic activity would generate more economic growth, and that agglomeration could be supported by integrating land-use and transport planning (p57).

However, the amended 2009 *Government policy statement on land transport funding* showed a change in priorities, due in part to the global financial crisis. It stated that the:

> *GPS closely reflects the modal choices that are realistically available to New Zealanders. Approximately … 84% of people go to work by car, truck or motorbike, so we need good roads to move freight and people. The government supports some mode shift over time, especially in our major cities of Wellington, Auckland and Christchurch, but considers that this should not be accelerated to the point where outcomes are economically inefficient* (p1).

This shift in priorities poses a challenge for public transport, but one that can be met. As indicated in the earlier sections of this report, network planning is designed to improve both services and efficiency, by raising occupancy levels and serving a wider array of trips. And networked public transport can promote urban economic growth not just by alleviating peak-period traffic congestion, but also by supporting the growth of strong central business districts and subcentres.

6.6 Conclusion

Public transport in New Zealand's major cities has benefited from supportive regional and local land-use planning policies, something that has not necessarily been the case in other countries. Many cities in North America and even Europe have lacked effective regional planning structures and policies, as the European Environment Agency noted in its report *Urban sprawl in Europe: the ignored challenge* (EEA 2006). At the time of writing, the Australian city-region of Brisbane had a metropolitan density only half that of New Zealand cities, owing to a long history of weak regional planning. Vancouver was less densely populated than Auckland and Wellington (see table 3.1), and while Zurich's population density was higher, its metropolitan area also had increasing problems with scattered semi-rural fringe development.

We found that New Zealand's policies on car parking were less public transport-friendly than those for our international comparator cities. In part, this reflected past attitudes that treated public transport as a back-up mode to the car, mainly for peak-period commuters. The challenge for the future is to integrate parking and public transport policies so that it is feasible to reduce parking requirements in centres as improved public transport alternatives became available.

Overall, this research has made it clear that there is considerable potential to improve public transport at an affordable cost and in ways that can contribute to the New Zealand government's strong economic growth agenda.

7 Conclusions

There is clear evidence that the network-planning approach to public transport service provision has produced impressive results in many European and North American cities. Patronage levels have grown considerably, while efficiency in the use of the public subsidy required by public transport operators has improved.

Three overseas comparator cities, approximately comparable in terms of urban form, demographics and public transport infrastructure, were selected to illustrate some best-practice examples of public transport service design that improved patronage levels and efficiency in the use of resources.

These comparisons have shown that New Zealand's three largest urban regions have considerable potential to build on the increases in public transport patronage and mode share that have been achieved during the last decade. Encouragingly, the greatest potential for improvement seems to lie with 'non-traditional' trip types, which could be accommodated without imposing commensurate increases in capital and operating costs.

We noted that the current situation regarding public transport operating practices in Auckland, Wellington and Christchurch reflected the broad history of decisions made in transport planning in each city over recent decades. Because of its smaller size and relative coherence in the institutional history of public transport service planning and delivery, Christchurch had been able to develop or preserve a number of important features of the network-planning approach, most notably a ticketing system that did not penalise passengers who made transfers. Its cross-town 'Orbiter' line, introduced in 2000 at the same time as common bus liveries and the unifying 'Metro' brand, had achieved a level of transfers that exceeded the expectations of local planners. However, in both Auckland and Wellington, we found that the ability of private operators to run 'commercial' services at will had hampered efforts to coordinate services and had allowed perverse competition between different public transport modes to continue. In Auckland, particularly, obvious opportunities to significantly reduce journey times through better coordination of rail and bus timetables had been overlooked.

Practical experience in the international comparator cities and elsewhere suggests three key areas of change that could improve public transport service planning in New Zealand cities.

1 Appropriate institutions and public processes:

- Establish a public agency to plan the network across the whole urban region.
- Redirect competition between private companies to the production of best-value tenders for the delivery of part, or all, of a publicly planned system.
- Use well-designed public education and consultation programmes to manage changes.
- Provide a simple fare system that avoids the imposition of penalties for transfers.

2 Network structure:

- Provide a simple and stable network of lines throughout the day.
- Base mode choice for different lines in the network on required capacity, comfort and speed.
- Consider locations for suburban interchanges on the basis of predicted travel patterns and efficient vehicle operations.

3 Network operations

- Simplicity and directness:
  - Organise the network on the principle of 'one section – one line'.
  - Avoid deviations in the physical routes chosen for bus services.
  - Provide pendulum lines through key activity centres and interchanges.
- Speed and reliability:
  - Aim for travel speeds comparable to, or faster than, door-to-door travel times that can be achieved by car.
  - Provide on-road signal and traffic-lane priority to allow buses to meet connections.
  - Aim to have vehicles stopping only as required to pick up and drop off passengers.
- Frequency:
  - Establish 'forget-the-timetable' headways (10 minutes or less) in key travel corridors.
  - Set up integrated timetables outside high-frequency areas.
- Location of stops and access to services:
  - Carefully plan the location of stops to minimise the number of stops and ensure their optimal location in relation to major trip attractors, intersecting lines and pedestrian accessways.
  - Locate stops in car-free precincts close to important destinations, to give public transport a significant competitive advantage.
  - Change current access to 'trunk' services from 'park-and-ride' facilities to access by walking, bicycle, or feeder bus, in order to cater for long-term growth in patronage.
  - Ensure that walking distances between services in interchanges are very short: preferably no more than 10 metres.
- Marketing for first-time and occasional users:
  - Create a simple line structure that makes the network easy to understand.
  - Use maps, on-line information, vehicle livery and on-board displays to reinforce understanding of the line layout and transfer opportunities.

While regional land-use planning in New Zealand cities has been increasingly recognising the need to promote transit-supportive urban forms, in particular by discouraging scattered and very low-density development, these policies cannot, on their own, ensure that public transport will improve. However, when coupled with the network approach to the design and delivery of public transport service, important gains could be made.

Although further research is needed to quantify the specific benefits, it is clear from the directions outlined in this report that considerable potential exists to improve public transport at an affordable cost and in ways that can significantly contribute to the government's strong economic growth agenda.

8 Recommendations

The research undertaken for this project has confirmed that considerable potential exists to adopt international best practices in public transport network planning in Auckland, Wellington and Christchurch to:

- improve the cost effectiveness of local public transport
- accelerate current trends in growth in patronage
- identify long-term requirements for future capital investment in new rolling stock and infrastructure.

On this basis, we recommend that:

- public transport agencies and governments direct significant resources to the development of detailed plans for networked public transport services, to direct future government recurrent and capital expenditure in public transport
- because the changes to existing services that will be required to implement a robust public transport network will inevitably result in public controversy, a well-designed and well-resourced process of public engagement is an essential part of the development of plans for networked public transport services
- in the development and implementation of such plans, the role of private operators in the design and delivery of public transport services will require clarification – while there can be operational efficiencies in having services delivered by private operators, coordination of service patterns and timetabling is best done by a public agency, which can put out to tender the day-to-day operation of different components of an over-arching network
- given the central government's strong focus on economic efficiency and growth, further research to quantify in more detail the economic benefits of the network approach, and to develop tools for comparing the efficiency of different network options, would be valuable.

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10 Appendices

Appendix A List of participants in consultative workshops

A1 Auckland, 11 February 2009

Name	Organisation
Dr Imran Muhammad	Massey University
Dr John Stone	GAMUT, University of Melbourne, Australia
Dr Paul Mees	RMIT University, Australia
Gustav Nielsen	Institute of Transport Economics, Norway
Brain Palalage	New Zealand Transport Agency (NZTA)
Anthony James	Auckland Regional Transport Authority (ARTA)
Emily Watson	ARTA
Anthony Cross	ARTA
Edwin Swaris	ARTA
Christine Rose	Auckland Regional Council (ARC)
Don Hougthon	ARC
Stuart Knarston	Auckland City Council (ACC)
Chris Harris	North Shore City Council
Steve Wrenn	Manukau City Council
Ahmed Khaled	Rodney District Council
Darren Davis	Waitakere City Council
Caroline Conray	Papakura City Council

A2 Wellington, 17 February 2009

Name	Organisation
Dr Imran Muhammad	Massey University
Dr John Stone	GAMUT, University of Melbourne, Australia
Gustav Nielsen	Institute of Transport Economics, Norway
Jeremy Traylen	New Zealand Transport Agency (NZTA)
Deborah Hume	NZTA
Brian Baxter	Greater Wellington Regional Council (GW)
Doug Weir	GW
Adam Lawrence	GW
Natasha Hayes	GW – Transport Strategy
Victoria McGregor	GW – Wellington Regional Strategy Office
Joe Hewitt	GW
Mike Vincent	GW
Wayne Hastie	GW
Angus Gabara	GW
David Lewry	GW
Paul Bruce	GW
Steve Spence	Wellington City Council (WCC)
Luke Troy	WCC
Paul Kos	WCC
Stephen Hawte	WCC
Ian Bainghen	NZBUS

A3 Christchurch, 19 February 2009

Name	Organisation
Dr Imran Muhammad	Massey University
Dr John Stone	GAMUT, University of Melbourne, Australia
Gustav Nielsen	Institute of Transport Economics, Norway
Rachel Gibson	New Zealand Transport Agency (NZTA)
Chad Bakers	NZTA
Mark Yaxley	NZTA
Tony Pinn	NZTA
Shannon Ussher	Environment Canterbury (ECan)
Wayne Holton-Jeffreys	ECan
Kirstin Schriffer	ECan
Paul Roberts	Christchurch City Council (CCC)
Philip Basher	CCC
Ken Stevenson	Waimakariri District Council
Andrew Mazey	Selwyn District Council

Appendix B List of participants in implementation workshops

B1 Christchurch, 28 September 2009

Name	Organisation
Dr Paul Mees	RMIT University, Australia
Dr John Stone	GAMUT, University of Melbourne, Australia
Tim Petersen	GAMUT, University of Melbourne, Australia
Dr Imran Muhammad	Massey University
Eliza Geelan	Environment Canterbury (ECan)
Sam Wilkes	ECan
Robert Wood	ECan
Shanon Ussher	ECan
David Falconer	Christchurch City Council (CCC)
Phil Hendon	CCC
Philip Basher	CCC
Ruth Foxon	CCC
Mark Yaxley	New Zealand Transport Agency (NZTA)
Ryan Cooney	NZTA
Chuck Dowdeu	Red Bus
Paul McNoe	Red Bus Ltd
Matt O'Malley	Leopard Coachlines

B2 Wellington, 2 October 2009

Name	Organisation
Dr Paul Mees	RMIT University, Australia
Dr John Stone	GAMUT, University of Melbourne, Australia
Dr Imran Muhammad	Massey University
Adam Lawrence	Greater Wellington Regional Council (GW)
Peter Glensor	GW
Paul Bruce	GW
Wayne Hastie	GW
Alexander Campbell	GW
Mike Mellor	GWR Transport Committee
Deborah Hume	New Zealand Transport Agency (NZTA)
Lyndon Hammond	NZTA
Bob Wallers	NZTA
Megan Kennedy	NZTA
Quintin Howard	NZTA
Keryn Zimmerman	NZTA
Mark Edwards	NZTA
Andrew Edgar	NZTA
Anna Daniel (Sunter)	NZTA
Pania Elliot	NZTA
Jacqueline Blake	NZTA
Michelle McCormick	NZTA
Julie Alexander	Ministry of Transport
Hela Chapman	Ministry of Transport
Steve Spence	Wellington City Council (WCC)
Wayne King	Hutt City Council
Denish Gandhi	Hutt City Council
Bryce Cameron	Hutt City Council
Paki Maaka	Hutt City Council
Michael Kargar	Kapiti Coast District Council
Geoff Strand	Kapiti Coast District Council
Jane Pearson	Kapiti Coast District Council
Lindsay Gow	Consultant
Paula Warren	Passenger advocate