Walking Networks and the Interaction with Public Transport

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Abstract: *Walking networks and the interaction with public transport has a large influence on the success of a sustainable transport system.*

This Technical Note describes how Christchurch became the first city in New Zealand to develop a walking network model and how this walking network is enabling Christchurch to test, optimise and provide for better public transport. The creation, manipulation, linkage and modelling of a walking network was executed within a GIS framework.

This Technical Note illustrates the development and application of the walking network modelling technique developed by Abley Transportation Engineers

INTRODUCTION

A walking network is a Geographic Information System (GIS) polyline dataset that enables modelling of pedestrian movements in a built urban environment. A walking network model expands on the traditional road centreline data model commonly used in transport modelling through the inclusion of walking links not available to vehicles. Walking networks also incorporate time factors such as pedestrian speed and forced delay at points such as road crossings. Through the use of GIS, pedestrian movement models can also be connected to public transport networks to model complete journeys taken by public transport.

A walking network differs from a road network as it allows for analysis to include real world scenarios where pedestrians are likely to use links that are not alongside roads. This includes walking paths through conservation areas, parks, schools and other off-road short cuts frequently taken by pedestrians. Walking networks allow for accessibility to be calculated and compared between users of different levels of mobility based on physical ability.

The Christchurch City Council (Council) commissioned Abley Transportation Engineers Limited (ATEL) to create a city wide walking network for Christchurch. The model was developed initially for analysis using Public Transport Accessibility levels (PTALs), and has since been used in a number of accessibility modelling projects. A central city model has been developed in addition to the Christchurch citywide walking network for the Christchurch central business district. The central city walking network has a higher level of detail and also includes multi level walking links such as over-bridges and public walkways through buildings.

BACKGROUND

As far as Abley Transportation Engineers Limited is aware, the Christchurch citywide walking network is the first and most extensive of its kind in New Zealand. The creation of the citywide walking network was an ambitious project with the inclusion of large amounts of detail over a wide area. When combined with public transport GIS data, it enables the testing of effects of manipulating bus route, bus frequency and walking connectivity when assessing accessibility to public transport. It also allows for the analysis of service areas of both the current, and any proposed public transport services.

NETWORK DEVELOPMENT METHODOLOGY

The first step in creating the citywide walking network was to create a base walking network. The base walking network was created using Council road centreline data. All road centrelines that run through rural land, mostly on the outskirts of the city, were not included in the process as it is unlikely that pedestrians would use a rural road for commuting or for access to public transport. In addition to this, rural roads do not provide good pedestrian facilities.

In order to best represent the location of footpaths at a citywide scale, a buffer was created around each road centreline link using Council road hierarchy attributes to estimate road width. Lines generated from the buffers formed the footpath links for the walking network. Network connections are formed where each buffer line intersects with another buffer line. The result of these connections is that the base network model allows pedestrian road crossings at every intersection on the road centreline network. The process was executed in iterations, each time with a different road width value. Figure 1 displays the base walking network layer on top of an aerial photograph for comparison between actual footpath locations and the walking network. After the formation of the base walking network, a number of significant changes were made to improve the quality of the walking network.

Figure 1 Base Walking Network

Improvements made to the base walking network are heavily based on existing GIS data. Edits and additions were made to the base walking networks to improve detail in areas where pedestrian numbers are high. The use of aerial photography was essential to identify walking links as well as walking barriers such as fences and buildings.

Manual edits which over-wrote the base network and additions to the walking network were made to district shopping areas, business retail parks and relevant land-use zones as classified by Council. Relevant land uses include open-space, conservation, cultural and some special purpose zones. Street crossings were also manually inserted at traffic lights, zebra crossings and pedestrian refuges where they had not previously been created. Street crossing links were given a time delay factor based on traffic signal cycle time or Tanners Model for calculating road crossing delay times. The length of walking links as well as time values for walking links based on pedestrian walking speed and crossing delay allows for pedestrian modelling based on time as well as distance.

A higher level of detail could be achieved through breaking walking links not only at intersections, but every time the type of pedestrian facility changes. Examples of this would include the addition of driveway crossings, commercial driveways crossings, street crossings other than main intersections and areas along roads where there are no footpaths, as it is accepted that pedestrians walk along these areas at different speeds than what they would a formed footpath.

APPLICATION OF THE WALKING NETWORK

ATEL have previously proven through other techniques that current practices for measuring the success of accessibility to a public transport system can be very simplistic. The creation of the walking network enables the calculation of journey times including delays when crossing the road and enhancements such as different delays based on the crossing type and the expected traffic flow on the road in different time periods. The walking network has been used in Christchurch for the calculation of Public Transport Accessibility Levels (PTALs) although its application is not limited to just the calculation of PTALs.

An example application is shown in the following figures where the bus stops within a certain walking time are identified, and for a sample bus route the closest bus stop located. These are some of the specific tests that have to be undertaken when calculating a PTAL. The bus stops and bus routes for a section of Christchurch central city are shown in Figure 2.

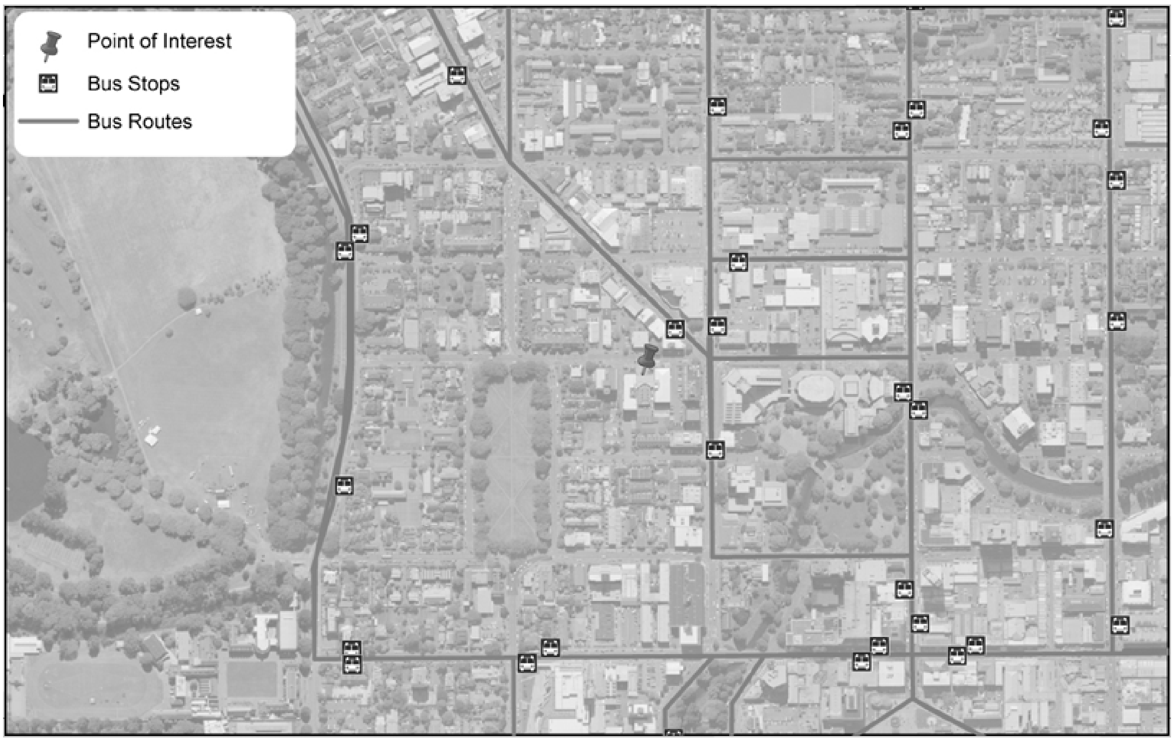

Figure 2 Bus stops and bus routes

The walking network is then added as shown in Figure 3 and the 8 minute walking range from a point of interest, in this case the main entrance to Environment Canterbury, is shown in Figure 4.

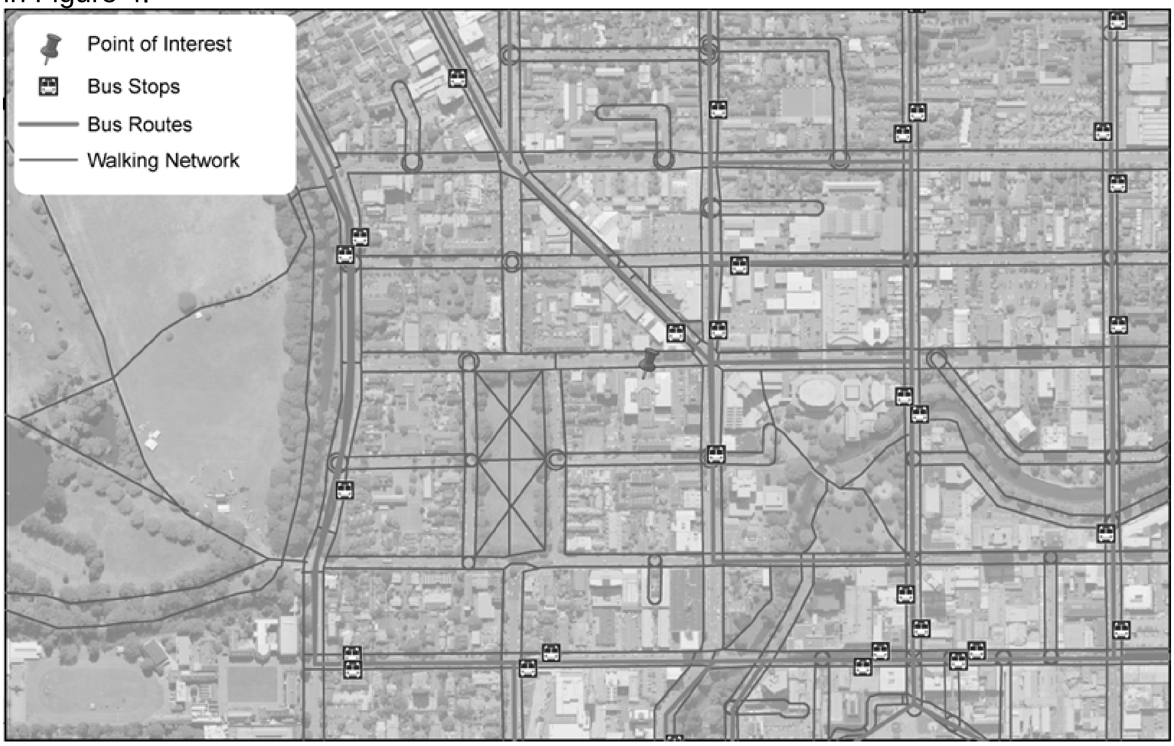

Figure 3 Addition of walking network

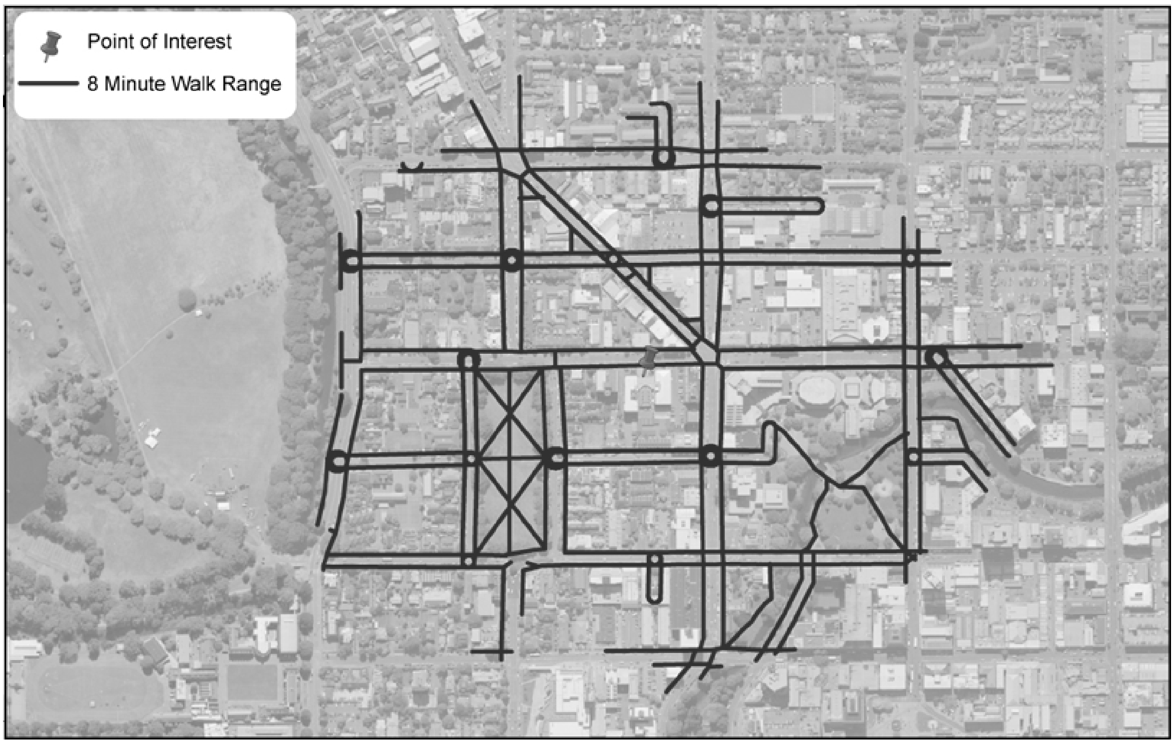

Figure 4 8 minute coverage from point of interest on walking network

It is the creation of this maximum walking limit using walking speed and crossing delays that enables the creation of the service area polygon as shown in Figure 5. For one sample bus route, route 28, the closest bus stop to the point of interest is determined as shown in Figure 6.

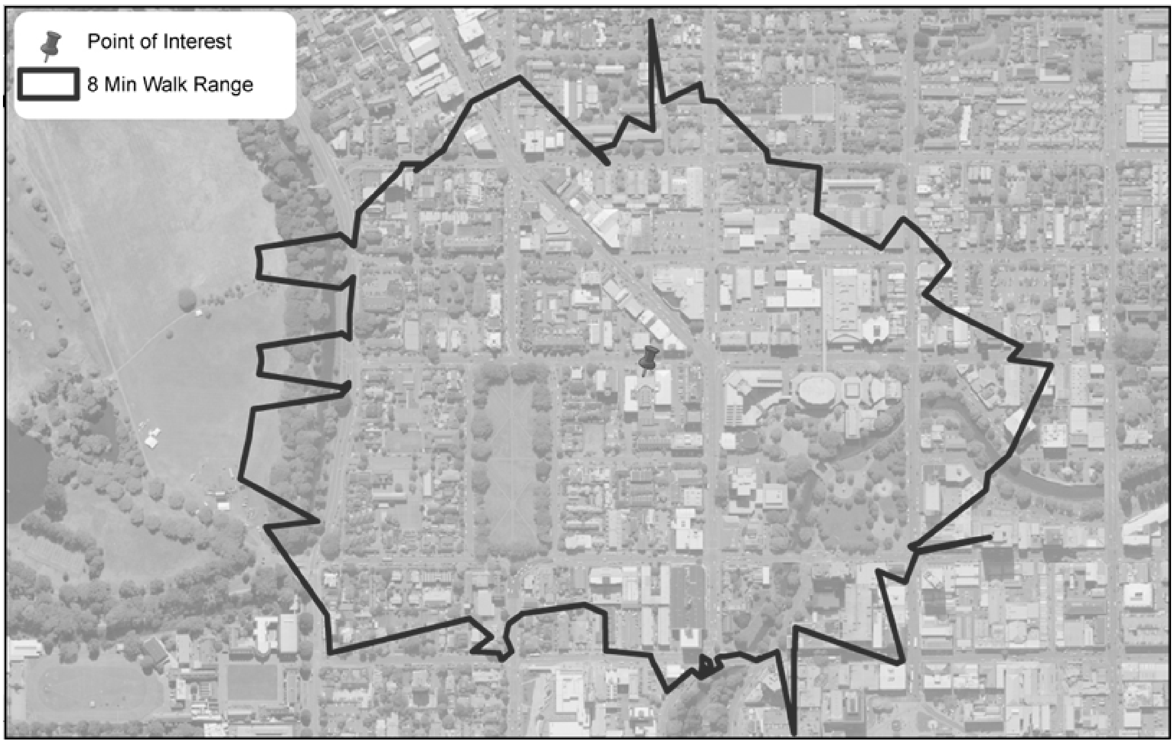

Figure 5 Conversion of 8 minute coverage to 'service area analysis'

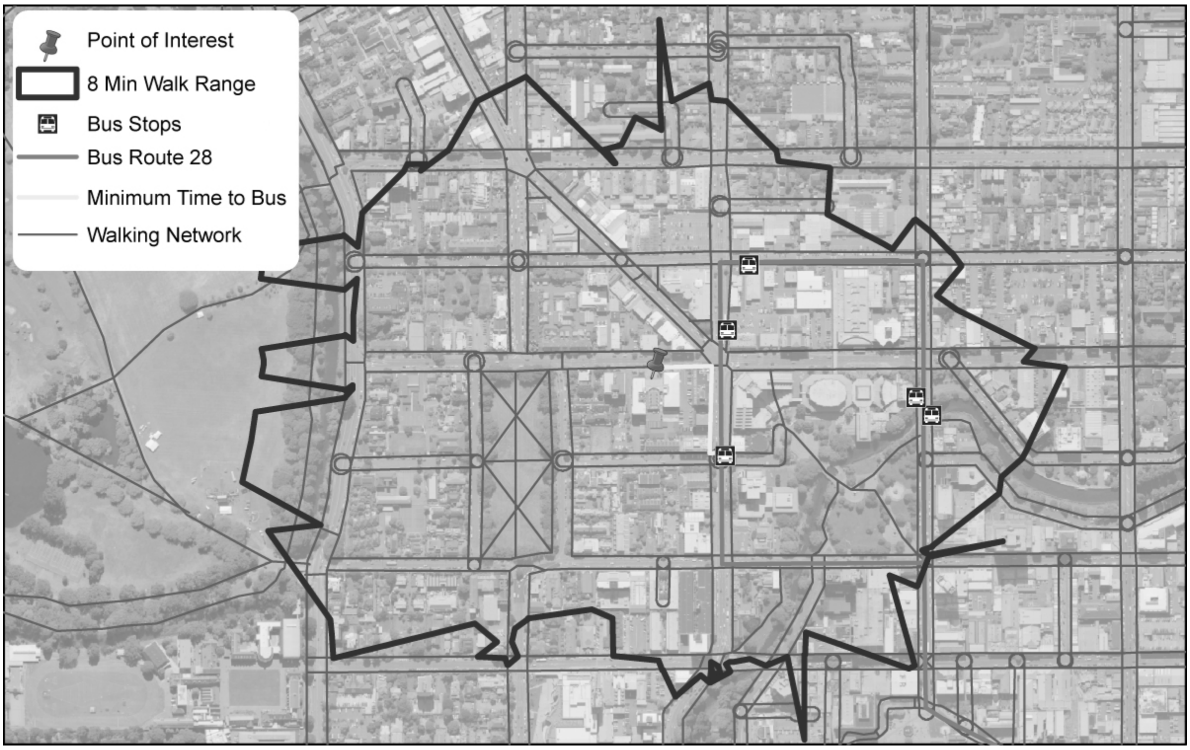

Figure 6 Closest bus stop location to point of interest

It is interesting to note that the walking network has enabled the 'true' closest 'by time' bus stop to be identified. It would appear logical that the northern bus stop would in fact be the closest facility although this involves crossing a nearby intersection twice, whereas the southern bus stop only requires crossing the road once. The time penalty delay accessing the southern bus stop is less than accessing the northern bus stop and hence, the southern bus stop is the closest by 'time' bus stop.

CONCLUSION

Walking networks are new to transport modelling in New Zealand. The walking network created for Christchurch City has been used in a number of accessibility based modelling projects and has proved to be beneficial for walking and calculating accessibility due to the higher level of detail provided over traditional transport models.

The production of the Christchurch city-wide walking network has resulted in an extensive detailed dataset. The use of the walking network for other public transport applications is expected. The walking network provides a high level of detail and is ready for automated GIS analysis. The development of a city-wide walking network is essential for good transport planning and has a variety of applications. The creation of a walking network is relatively inexpensive within a GIS framework because it makes good use of existing resources.

RECOMMENDATIONS

Abley Transportation Engineers Limited recommends that:

- Expansion of the Christchurch City Wide Walking Network to include a higher level of detail.
- Linking the Christchurch City Wide Walking Network with neighbourhood accessibility assessments.
- Other regional and local authorities consider creating walking networks for their communities.