greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

FILE NOTE

DATE 23 October 2012

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SUBJECT **Appendix 8**: Coding of Interchanges for PTSS

1. Introduction

This notes details a proposed approach to improve the representation in WTSM and WPTM of transfers between public transport services, for the Public Transport Spine Study (PTSS) short list modelling.

Currently within the Wellington region relatively few transfer trips take place (both inter and intra modal) and therefore the issue of accurately modelling transfers is not of paramount importance.

However, the PTSS LRT and BRT schemes are partly based upon the principle of terminating some bus services at locations such as Kilbirnie and Newtown and forcing their passengers to transfer onto LRT / BRT. In addition, as part of the Wellington City Bus Review (WCBR) it is proposed to create a system of feeder bus services that will connect with core bus services at a series of pre-determined 'interchanges' where a minority of passengers will have to transfer. Finally, and partly in relation to the WCBR, it is also proposed that an integrated ticketing system is implemented in the region, facilitating easier and cheaper transfers between services.

As a consequence of these schemes, it is important that the perceived inconvenience and additional monetary cost of transferring between services (as well as their mitigation, e.g. through upgraded interchanges and integrated ticketing) is accurately modelled in order for the PTSS assessment to capture the impact of the potential increase in transfer on public transport demand.

2. Current Coding in WTSM and WPTM

The EMME transport planning software used to develop WTSM and WPTM does not distinguish between first boarding and subsequent transfer boardings, as well as transfer between same modes or different modes. As a result, there is currently a simplification in the way transfer penalties are coded. This also impacts on fare calculation, as it is not currently possible to apply different fares for initial or subsequent boardings in the PT assignment. Both models follow a different approach to deal with this limitation, which is detailed below.

2.1 WTSM

Assignment

Boarding penalties in WTSM are applied through a node attribute (@board). The boarding penalty components breakdown is detailed in the following table.

Table 1 Boarding Penalty Components in WTSM

@board Component	Value for bus (min)	Value for rail (min)
Boarding time	3	3
Transfer Penalty	10 by default 5 for high quality interchange	7.5 by default 2.5 for high quality interchange
Fare	10 (proxy for average fare)	10 (proxy for average fare)
Total	**23 by default**	**20.5 by default**

In the WTSM assignment phase, every boarding, including the initial boarding, incurs a transfer penalty in addition to the actual boarding time. While this intuitively appears incorrect, it does not effect significantly the assignment as it does not greatly impact on the selection of the strategy or PT mode, all services including the same extra penalty. This transfer penalty is currently 10min by default for bus stops, and can be decreased for improved facilities or dedicated interchanges.

While it can be expected that this extra penalty might lead to too many trips assigned to walk-only, the WTSM 2001 documentation (TN14_2 Base Public Transport Network) shows that this only occurs for a negligible number of ODs.

The boarding penalty also includes an extra 10min proxy for fare cost, representing the average fare and applied to all stops and stations in the transit network.

Generalised Costs Calculation

The total boarding penalty for each OD is then skimmed after the assignment and the resulting matrix is fed into the PT generalised costs calculation, after removal of the transfer penalty for the initial boarding and of the fare proxy component.

The actual fare information used in the generalised cost calculation is contained in a fare matrix, which was revised during the 2011 update of WTSM. This calculation was based directly on the current Metlink fare zone system, and using skims of the number of boardings and fare zone crossings for each OD. The fare from zone to zone was then calculated for both AM and Inter peak periods based on the number of fare zone boundary crossings and service boardings.

The fare matrix calculation was a “one-off” undertaken for the model update and it is not currently recalculated during a model run, i.e. the current fare matrix would not reflect any changes in the number of zone crossing or service boarding caused by changes to the public transport network.

2.2 WPTM

In a WPTM assignment, transfer penalties are not explicitly coded, the only penalty being therefore any additional boarding time caused by transfer between services. Boarding penalties are coded as a combination of line and node boarding penalties, equating to between 3 and 6 minutes of generalised cost.

The current fare system in WPTM represents the cost of each journey in terms of a boarding fare component (flagfall fare) for each leg of a PT trip and an additional fare component for each zone boundary that is crossed. **Table 2** shows the average fare table used in the transport model. Whilst in reality the zonal component of fare does not increase in a strictly linear fashion (i.e. according to Metlink, the Adult cash fare increases by $1.00 when going from a 2 to 3 zone fare but by $1.50 when going from a 3 to 4 zone fare), a linear approximation of the relationship was made for modelling purposes as EMME cannot easily model non-linear fare relationships.

Table 2 AM Peak Average PT Fares – WPTM

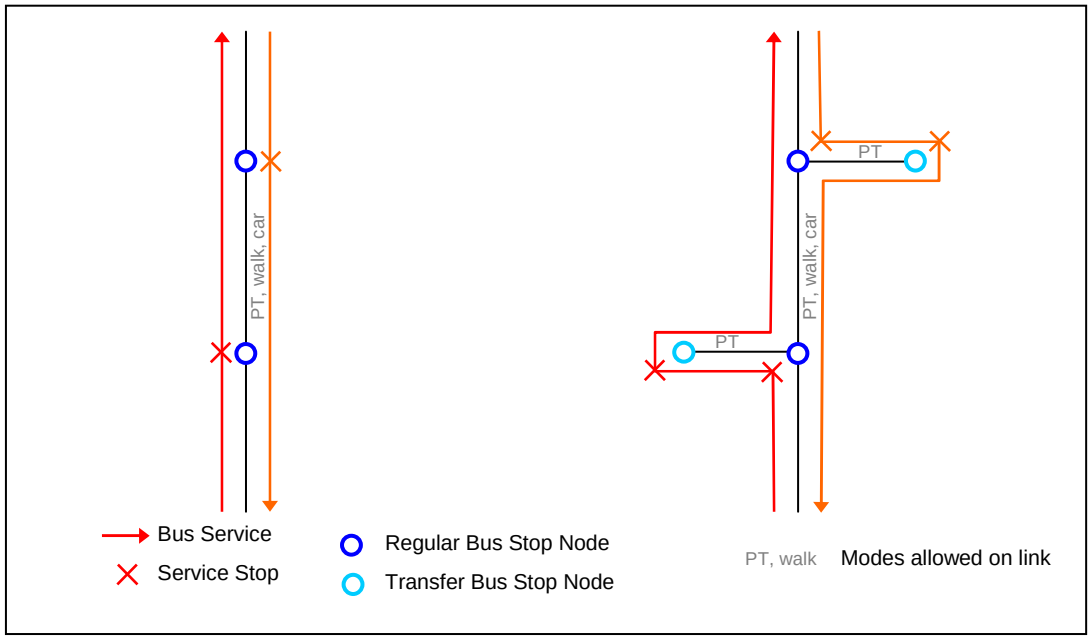
Mode	Flagfall Fare ($)	Zone Boundary Component ($)
Rail	$1.90	$0.70
Bus	$1.90	$0.70

3. Proposed Modelling Approach

3.1 Interchange Network Coding

As mentioned before, the main issue with modelling perceived time penalties and different boarding fares caused by transfer between services is the inability of EMME to distinguish between initial boarding and transfer boarding, making it impossible to have different parameters for different categories of boardings. This section details a proposed approach, valid for both WTSM and WPTM as they share the same network, to get around this limitation through the addition in the network of virtual "transfer nodes" at some key locations. These additional nodes can be a representation of dedicated interchanges, but can also be used to model regular PT stops where a high level of transfer is projected to occur under certain schemes. The following figure shows a representation of the proposed coding.

Figure 1 Proposed Interchange Coding

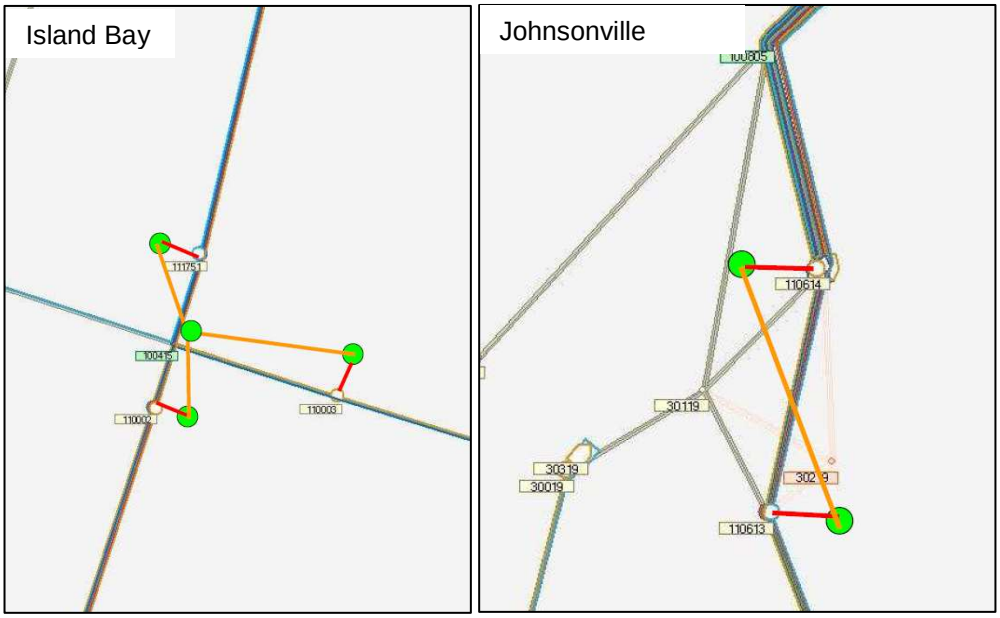


Selected bus (or other modes such as BRT and LRT) stops will be recoded as per the figure above, which will allow for different boarding penalty and fare parameters to apply at the "regular" node and at the "transfer" node. These different parameters could for example be no fare cost at the transfer node to account for integrated ticketing, or reduced transfer penalty for high quality interchanges (the proposed parameter changes are detailed in the following sections).

Only interchanging passengers can board at these transfer nodes. No initial boarders can access the transfer node as the links attached to the node are transit only (i.e. no walking allowed). Similarly, nobody can alight at the transfer node and walk to the road network for the same reasons. Transferring passengers will naturally use the interchange node as it will be more attractive due to reduced fare or transfer penalty.

In some cases, it might be likely that some transfer will occur between services that do not follow the same route but stop at nearby locations. This can be dealt with by adding a walk link between the relevant transfer nodes, to allow passengers alighting from one service to board other services nearby without accessing the road network. The following figure shows two example of this coding, with the link in red being PT only and the link in orange being walk only.

Figure 2 Proposed Interchange Coding



3.2 Transfer Parameters in WTSM Assignment

Transfer Penalties

Using the interchange coding detailed above in WTSM, different transfer penalty could be applied for passengers transferring at a designated interchange. At present, the default transfer penalty is 10 minutes, but the WTSM original documentation recommends values of 8 minutes for purpose built interchanges and 5 minutes for high quality interchanges. Other suitable values could also be sourced from international guidelines or examples.

Fares

The boarding penalty in WTSM includes a 10min fare proxy component, representing the average fare and applied to all stops in the transit network. If integrated ticketing was implemented, this component should be reduced for the second leg of a PT journey since the boarding fare would be removed for transferring passengers. The proportion of this 10min penalty that should be removed to account for boarding fare removal can be calculated from fare analysis carried out for the WPTM development (see Wellington Transport Models TN1 – Network Preparation).

However, it can be argued that the fare for any subsequent service being used should be set to zero., since having a fare paid for every boarding (even reduced fare) would still make a journey involving two legs less attractive than a single leg trip. Since this fare component is really a proxy, the fare paid for both single leg and multiple legs trip should be the same with integrated ticketing. More analysis might be needed to determine the impact of this change and the sensitivity of the model to this parameter.

3.3 Transfer Parameters in WPTM Assignment

Transfer Penalties

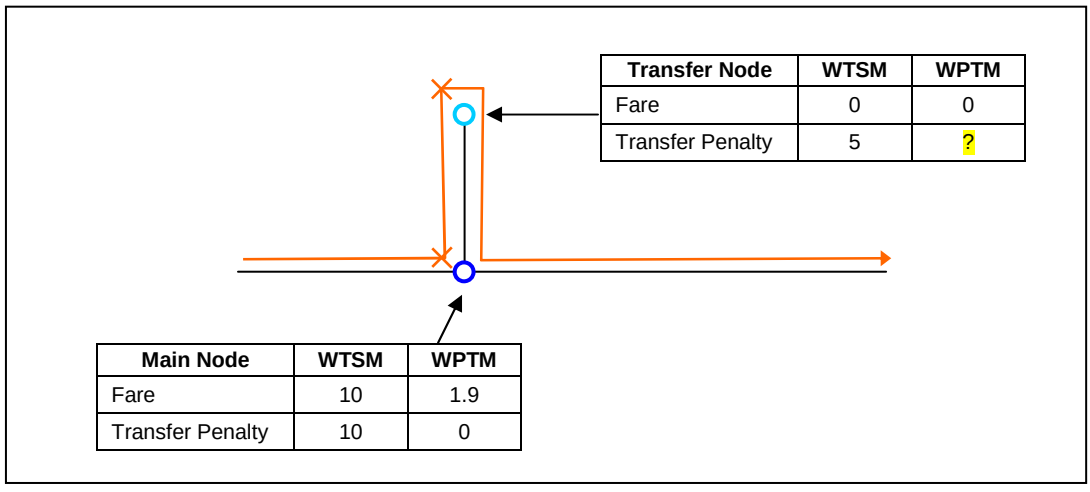
None

Fares

Similarly to WTSM, the fare will be reduced at interchange nodes to account for integrated ticketing. In WPTM however, this reduction in fare can be much more accurate due to fares being calculated during the assignment. In this case, the flagfall component of the fare will be removed for transferring passengers, with passengers on the second leg of their trips paying only for fare zone boundary crossings.

The following figure presents an example of parameters for the proposed interchange coding, for both WTSM and WPTM.

Figure 3 Transfer Node Parameters



3.4 Changes in WTSM Generalised Costs Calculation

Due to the way PT generalised costs are calculated in WTSM, some adjustments have to be made so that the modelling of interchange in the assignment doesn't impact on the generalised costs calculations.

Generalised costs (expressed in minutes) are a function of walking time, waiting time, in-vehicle time, boarding penalty, fare and value of time, with the equation being as follows:

GC = [In-veh time] + 2*[Waiting time] + 2*[Walking time] + [Boarding penalty] + [Fare]/[VoT]

The fare for each O-D is derived from a fare matrix, however the boarding penalty also include the 10min fare component used during the assignment, to approximate the actual cost of boarding a service. There is therefore an element of double-counting fare which is dealt with in the base WTSM by subtracting 10min per boarding to the total boarding penalty skimmed after the assignment.

Additionally, due to the inability of EMME to differentiate regular and transfer boardings, every boarding in the assignment currently incurs a transfer penalty. This penalty needs to be removed for the first boarding before the generalised costs are calculated, and as an approximation WTSM calculates the average transfer penalty per boarding for a given OD, and then subtract it to the total boarding penalty. The equations used to include these two adjustments are as follows:

Boarding penalty = [Skimmed boarding penalty] – [Initial transfer penalty] – [No. of boardings] * 10

and

Initial transfer penalty = ([Skimmed boarding penalty] – [No. of boardings * 10])/ [No. of boarding] – 3[1]

For the new interchange / integrated ticketing modelling, these equations need to be adjusted to account for the fact that a reduced fare is being paid at interchanges in the assignment. This can be done by subtracting the number of boardings at interchange (skimmed using a new attribute during assignment) to the total number of boardings. The resulting equations are as follows:

Boarding penalty = [Skimmed boarding penalty] – [Initial transfer penalty] –
([No. of boardings] – **[No of boardings at interchange])*** 10 **– [No of boardings at interchange] * reduced fare**

and

Initial transfer penalty = ([Skimmed boarding penalty] –
([No. of boardings] – **[No of boardings at interchange])*** 10 **– [No of boardings at interchange] * reduced fare**)/ [No. of boarding] – 3

Note: the fact that in WTSM the transfer penalty that gets removed from the initial boarding is based on the average transfer penalty for an O-D, and not the actual value for this first boarding is an approximation, and as a result impacts slightly on the resulting costs and demand. This issue

[1] These 3 minutes represents the actual boarding time

doesn't invalidate the approach but it might be worthwhile to carry out more investigation to estimate the impact of this approximation on results.

3.5 Fare Calculation in WTSM

As mentioned in Section 2.1, the fare matrix calculation is not currently part of a WTSM model run and the current matrix is therefore based on the existing Metlink services and fare structure.

In order to replicate the changes in fares caused by modifications to PT services (such as additional boardings) or integrated ticketing, and their potential impact on generalised costs and therefore trip distribution and mode choice, it is necessary to recalculate this fare matrix with the new services and fare system in place.

Since the process set up during the WTSM 2011 model update to recalculate the fare matrix can be easily rerun with any new PT network or fare structure, it is proposed to include this calculation in WTSM model runs for the PTSS modelling. This more dynamic approach would ensure that the fare matrix used in generalised costs calculation would always be an accurate representation of the PT services in place and the fare system used.

As an example for integrated ticketing, the current $2 charge (undiscounted) for boarding a service in the Metlink system could be applied to the first boarding only and waived for any subsequent boarding.

3.6 Rail to Bus Transfer

Similarly to passengers transferring between buses, passengers transferring between rail and bus also currently pay a boarding fare for both legs of their trip. Although bus-rail transfers are not deemed to be of significant importance for this study for most rail stations in the region, transferring occurring at Wellington station (over 1,000 transfers in the AM Peak) must be accurately represented as it can have a significant impact on potential transfer to new modes introduced as part of the PTSS.

The proposed approach for Wellington station would be similar to the coding for bus to bus transfer and is illustrated in the following figure.

Figure 4 Proposed Coding at Wellington Station