SMARTTRACK RIDERSHIP ANALYSIS

EXECUTIVE SUMMARY

Prepared for the City Manager, City of Toronto

by:

Eric J. Miller, Ph.D.
Professor, Department of Civil Engineering
Director, Transportation Research Institute
Research Director, Travel Modelling Group
University of Toronto

James Vaughan & Monika Nasterska
Travel Modelling Group, University of Toronto Transportation Research Institute

June, 2016

UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING
Transportation Research Institute

UTTRI

Executive Summary

Project Objectives

On December 11, 2014, City Council directed the City Manager in consultation with the Province/Metrolinx to develop a work plan to undertake an accelerated review of the SmartTrack and RER plans. Council also directed the City Manager to retain the specialized services of the University of Toronto Transportation Research Institute (UTTRI) to support the planning analysis and required transit ridership modelling as a component of the overall review.[1] On February 10, 2015, City Council considered the report *EX2.2 SmartTrack Work Plan (2015-2016)*, and approved the accelerated work plan for the review of SmartTrack.[2]

The UTTRI component of this work was to provide transit ridership estimates and other key network performance measures using the City's new Regional Travel Demand Model (GTAModel Version 4.0) developed at the University of Toronto by UTTRI. As detailed in the final Terms of Reference for the UTTRI work, this work included:

- Confirming the integrated RER and SmartTrack Service Concept to be modelled.
- Completion and validation of a new travel demand model system to be used by the City of Toronto in this and similar studies of transit ridership and travel demand.
- Development and review of forecasting assumptions that provide key inputs into the transit ridership forecasts.
- Generating transit ridership forecasts for the identified range of future year networks and input scenarios.
- Analysis and comparison of ridership forecast results.
- Documentation and reporting of all work and results.

This study did not deal with:

- Detailed engineering design considerations of route alignments and stations.
- Capital and operating costs of alternative network designs.
- Financing mechanisms to pay for the construction and operation of network additions.

Thus, this study focuses solely on the transit ridership levels and other system performance measures that are likely to occur if various transit network improvements are made. While the primary focus of this analysis is on options for the proposed SmartTrack line, this line cannot be considered in isolation of the overall Greater Toronto-Hamilton Area (GTHA) transit network and, in particular, other major transit infrastructure proposed investments, notably GO RER plans, Scarborough Subway Extension (SSE) options, and Relief Line (RL) options (formerly often referred to as the Downtown Relief Line). Similarly, the future is a very uncertain place, and so ranges of estimated ridership need to be generated across a variety of possible future year growth scenarios and other assumptions. Given this, a wide range of combinations of network investment and growth scenarios are generated in this study and results are compared in detail.

[1] http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2015.EX1.12.
[2] http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2015.EX2.2.

Ridership Forecasting Approach

The transit ridership forecasts are generated using a large computer simulation model system called GTAModel V4.0. This model system simulates all trips made by all persons in the GTHA by all modes for all trip purposes over the course of a "typical" 24-hour weekday. Travel demand forecasting model systems are routinely used by urban regions around the world to systematically estimate future transportation system usage under a variety of policy and investment scenarios. Such a detailed, comprehensive modelling approach is essential for adequately assessing the impacts of any major transportation investment such as SmartTrack for many reasons:

- The entire transit network is modelled, not individual lines in isolation. Synergistic network effects are thereby captured that cannot be accounted for in analysis of a single line.
- The actual spatial origin-destination pattern of trip-making is explicitly accounted for. In other words, the entire travel market is modelled and the role which a given line plays in serving this overall market can be explicitly examined.
- Sensitivities to transit service frequencies, fares, travel times, stop locations and spacing, etc. can be simultaneously and consistently examined.
- The model is sensitive to assumptions concerning future year population and employment distributions.
- Competition from the road network (as well as walk/bike modes) is directly modelled. Transit investment impacts on roadway usage/congestion is directly modelled, as is the impact of auto service levels on transit ridership.

Two forecast years are examined for all options:

- 2031: This is the standard GTHA forecast year. The bulk of the analysis focusses on this benchmark year. Most experience exists with generating population and employment forecasts for this year.
- 2041: This represents a longer-term "mature" system analysis end date. Population and employment forecasts are more speculative given the more distant date.

The analysis strategy involves developing for each forecast year a "base" network which consists only of existing and committed (funded) projects and which excludes SmartTrack and the other lines of interest. The various new network options are then incrementally added to the base network so that the changes in system performance due to these network additions can be assessed across a variety of ridership and other performance measures,

Ridership forecasts have been generated for a wide combination of SmartTrack scenarios concerning fares, frequencies, including:

- Alternative SmartTrack service headways (15, 10 and 5 minutes).
- Alternative SmartTrack fares (TTC; GO).
- Alternative "western alignments" of SmartTrack beyond Mount Dennis.
- Alternative population and employment scenarios.

Key Findings

(a) SmartTrack

Key findings of this study with respect to SmartTrack include the following:[3]

- The ridership analysis clearly demonstrates a very significant market potential for SmartTrack, with potentially in the order of 300,000 riders per day with a 5-minute service headway. This far exceeds any other rail project under current consideration by the City of Toronto (including the under-construction Eglinton Crosstown LRT and the proposed GO RER system) and is only exceeded by the Yonge-University-Spadina and Bloor-Danforth subway lines within the existing TTC network.
- Ridership is very sensitive to both fares and service headway (frequency). Maximization of ridership requires high frequency service and is significantly enhanced if TTC rather than GO fares are applied to the system. Considerable latent demand for transit appears to exist within the system that can be realized if attractive transit services are provided that tap into the natural spatial pattern of this demand. SmartTrack clearly does this when operated at higher frequency levels.
- The attractiveness of through-service between the Stouffville and Kitchener lines at Union Station is validated, with significant through movements occurring in both directions at Union Station, especially at higher service frequencies.
- Further, emerging/planned nodes at both Liberty Village to the west of the downtown core and the Unilever site to the east represent important new transit and development nodes that are very well served by SmartTrack. SmartTrack provides the ability to "seamlessly" extend the traditional downtown into attractive new development areas.
- SmartTrack clearly outperforms the Base RER Service Concept from a ridership perspective, even at higher headways, regardless of design scenario considered. The SmartTrack concept is one of an "urban metro" (subway) in which a greater number of stops, significantly higher frequency, and all-day, two-way service much better meets the needs of not just commuters (short- as well as long-distance) but a much wider range of trip-makers in general. As clearly shown by the ridership analysis, it is this style of service that is required to divert auto users to transit (on the one hand) and to provide enhanced transit service to beleaguered current transit riders (on the other). As noted above, such a service is capable of tapping into the latent demand for transit that exists, providing that the service concept is fully implemented.
- Largely based on cost and constructability considerations, the City of Toronto has elected to proceed on the assumption that the Eglinton Crosstown LRT will be extended west from Mt. Dennis, rather than the originally proposed continuation of the heavy-rail line branching from the Kitchener line at that point. From the ridership analysis undertaken in this study, there is relatively little difference among these alternative alignments.
- The "reverse flow" outbound in the morning and inbound in the afternoon to/from the termini of SmartTrack at the Mississauga Airport Corporate Centre (MACC) in the west and Unionville/Markham in the north-east that had been hypothesized by some to be potentially large does not materialize in this analysis to any significant degree. This,

[3] Note that these findings generally are for the case in which TTC fares are applied to the SmartTrack, in keeping with the SmartTrack design concept as an "urban metro" and as integrated, key component of the overall Toronto transit network. Ridership is found in this study to be very sensitive to fares. Application of higher fares (such as current GO fares) would reduce ridership considerably.

however, may well reflect the current lack of good "last mile" solutions for getting commuters from the suburban train stations to their actual workplaces. This is a common challenge facing all rail lines (including the Base RER Service Concept) in attracting significant "reverse flow" into lower density suburban areas.

- Providing that key stations are included in the system (notably Liberty Village and Unilever) overall ridership does not appear to vary dramatically with the inclusion or exclusion of some of the more minor "intermediate" stations along the alignment. Thus, a "Phase 1" system with less than the full build-out is certainly conceivable and should be successful. This does not imply, however, that additional stations will not be required so as to maximize the full potential over time. Provision for the full suite of stations over the longer term should certainly be made in designing the line, and more detailed analysis of the ridership opportunities (and overall benefit-cost trade-offs) should be undertaken.
- The currently proposed "Options C and D" presented to Council in March 2016 both represent improvements over the Base RER Service Concept with respect to ridership. It is clear, however, that they do not represent optimal designs with respect to ridership maximization, which requires higher service frequencies.
- SmartTrack offers significant "relief" to the over-crowded Yonge line, especially when it is run at higher frequencies. It can both divert people travelling from the east away from using the Bloor-Danforth line (thereby reducing the number of transfers occurring at the critical Bloor-Yonge interchange station) and people travelling from the north away from the Yonge line altogether. As discussed below, none of the Relief Line "Little-J" corridors will provide adequate long-term relief to Yonge, and SmartTrack is seen to be an important element in addressing this chronic, long-term challenge. The potential extension of the Relief Line to Sheppard Avenue, however, offers the prospect of more significant long-term relief to the over-crowded Yonge line.
- SmartTrack's catchment area – the spatial extent of the trip origins and destinations using the line – is very large. The five-minute headway catchment area covers 55,000 hectares and serves a total 2031 travel market of nearly 3 million people and 7.4 million total daily trips. Comparable numbers for the Eglinton Crosstown, for example are 18,800 hectares, 1.3 million people and 4.4 million total daily trips.
- SmartTrack provides enhanced transit network connectivity throughout much of the City of Toronto, linking with many major east-west transit routes. It makes these routes more productive, while at the same time reducing over-crowding on both the Yonge and the Bloor-Danforth subway lines. In particular, the Stouffville portion of the line provides a new "transit spine", analogous to the Yonge line, upon which a significantly improved Scarborough transit network can be built

(b) Relief Line

Analysis of the interaction of SmartTrack with the proposed Relief Line (RL), for various RL corridors, was also undertaken. The focus of this analysis was not to provide a detailed examination of the RL, but primarily to understand the likely interaction between it and SmartTrack.

Notable findings from the Relief Line corridor analysis, presented in Chapter 5, include the following:

- Depending on the corridor, ridership on the "Little-J" RL (which links the Bloor-Danforth line from a station east of the Don River with the downtown core) is projected to range from 14,300 to 30,200 trips in the peak hour and from 86,800 to 186,800 on a daily basis. This is almost entirely existing ridership that is diverted to a less crowded and/or faster route by using the RL.
- SmartTrack is not a major competitor to the RL. A 5-minute SmartTrack service does reduce RL ridership somewhat, but not excessively.
- A primary rationale for the RL is to provide "relief" to the Yonge subway line by diverting riders (particularly in peak periods) to the RL. Findings with respect to this issue include:
    - The "Little -J" RL alone will at best bring the 2031 Yonge line ridership south of Bloor in the AM peak (the critical point in the system) to approximately the assumed line capacity of 36,000 passengers/hour.
    - This capacity shortfall becomes worse if the Yonge Subway is extended to Richmond Hill (the Yonge Subway Extension or YSE),
    - This capacity shortfall is also worse in 2041, regardless of whether the YSE is built or not.
    - The combination of the "Little-J" RL and a 15-minute SmartTrack service reduces the Yonge AM peak ridership to somewhat below capacity in 2031.
    - Much more significant reductions below the Yonge capacity is obtained with both the "Little-J" RL and a 5-minute SmartTrack service in 2031, a clearly very desirable state to achieve for a variety of reasons.
- RL corridors that include a stop at Unilever generate less relief of the Yonge line due to the more circuitous, slower route from the Danforth line into the downtown.
- From a ridership perspective, the various King corridors out-perform the Queen corridors.
- The catchment area and overall impact on network operations of the RL are much smaller than that projected for SmartTrack.
- The "Big-J" RL corridors investigated (selected "Little-J" corridors extended northward from the Bloor-Danforth line to Sheppard Avenue) provide enhanced relief for the Yonge line and, in general, attract significant ridership in the 2041 forecast year,
- Based on this ridership analysis, both the RL and SmartTrack are attractive additions to the Toronto transit network, providing significant new capacity into the downtown and significant relief to the Yonge subway line.[4] For both the 2031 "Little-J" RL and the 2041 "Big-J" RL cases examined, it appears that <u>both</u> the RL and a high-frequency SmartTrack service will be required to provide adequate Yonge line relief, as well as to meet other objectives for enhanced transit capacity into the Toronto downtown.

Subsequent to the analysis of the various RL corridors discussed in Chapter 5, City Planning has undertaken a more refined analysis, including updated service assumptions, of two alternative

[4] They also both provide much-needed redundancy within the network in terms of alternative routes in and out of the downtown when the Yonge and/or University line downtown segments are temporarily shut down for one reason or another.

alignments within the Queen" corridor in support of preparing an initial Business Case for the RL. These two "Little-J" alignments are referred to as option "AQ" (Pape to downtown via Queen Street) and option "EQ" (Pape to Eastern Avenue, with a stop at the Unilever site, then on to downtown via Queen Street). These options were also examined in conjunction with the prototype integrated SmartTrack/RER service concept "Option C".

Notable findings of the refined analysis, presented in Chapter 6, include the following:

- Depending on the alignment, the projected peak hour ridership ranges between 26,800 and 28,700 and between 165,500 to 177,100 riders on a daily basis.
- The integrated SmartTrack/RER "Option C "service concept is not a major competitor to the RL. In terms of providing "relief" to the Yonge subway line, findings include:
    - The "Little J" RL will bring the 2031 AM peak hour Yonge Line ridership south of Bloor to below capacity (alignment AQ) or just above capacity (alignment EQ).
    - The combination of the "Little J" RL and the integrated SmartTrack/RER Service "Option C" reduces the Yonge AM peak hour ridership to comfortably below capacity in 2031.
    - By 2041, the "Little J" RL alone will not be able to reduce the Yonge AM peak ridership below capacity. The combination of integrated SmartTrack/RER Service "Option C" and the "Little J" RL will bring the Yonge AM Peak hour ridership to capacity (alignment EQ), or just below capacity (alignment AQ).
    - The combination of the "Big J" RL (extended to Sheppard Avenue) and the integrated SmartTrack/RER Service "Option C" that reduces the Yonge AM Peak hour ridership comfortably below capacity in 2041.
- The extended "Big J" versions of the alignments attract significant ridership and provide enhanced relief to the Yonge Line.
- The extension of the Yonge subway to Richmond Hill (the Yonge Subway Extension or YSE) was also analyzed with RL option EQ. This analysis shows that:
    - The capacity shortfall (at Yonge south of Bloor) is worsened due to the addition of the YSE.
    - The combination of integrated SmartTrack Service "Option C" and the "Little J" Relief Line alignment EQ does not provide enough relief to reduce the Yonge AM peak hour ridership to capacity.
    - By 2041, the capacity shortfall due to the addition of the YSE is further worsened. The only combination that is able to reduce the Yonge AM peak hour ridership to capacity is that of the "Big J" Relief Line alignment EQ and the integrated SmartTrack/RER Service "Option C".

(c) Scarborough Subway Extension

Various options for the Scarborough Subway Extension (SSE) were examined in relationship to SmartTrack. Initially, several three and four stop alternative alignments were considered, generating the following key findings:

- The projected ridership for the multi-stop SSE options examined is not out of range from what one might expect for the end stations of long line running into a suburban region.
- The introduction of SmartTrack does reduce SSE ridership, as expected. Somewhat analogous to the RL – SmartTrack case, the SSE and SmartTrack are primarily designed

to address different markets: the motivation for the SSE is specifically to provide a high-quality connection between the Scarborough City Centre and the rest of the TTC network; while SmartTrack provides a major new north-south "transit spine" for the entire Scarborough transit network, as well as significantly enhanced connectivity for Scarborough and Markham into the Toronto downtown. Thus, as in the RL case, it is not a question of "either/or" between SSE and SmartTrack but rather what the best design for each might be so that each best contributes to overall transit service within the City of Toronto (and beyond).

During the course of this study the concept of a "one-stop" SSE option that would provide an "express" service from Kennedy Station to the Scarborough City Centre was introduced by City Planning. This option was briefly examined within this study in conjunction with the prototype integrated SmartTrack/RER service concept "Option C". Findings from this analysis include:

- Reducing the SSE from three to one stops reduces peak hour ridership on the line by approximately one-third (from 11,100 to 7,300 and daily ridership by 38% (63,800 versus for the 3-stop case of 103,000).
- Implementation of the Eglinton East LRT has a very marginal impact on the SSE, since it is largely serving a somewhat different catchment area.

Based on the very preliminary analysis undertaken to date, the Eglinton East LRT may attract in the order of 38,000 riders per day in the 2031 horizon year.