Transportation

Metrolinx

US & USRC Track Capacity Study
Train Capacity Analysis
Present to Maximum Capacity and Beyond

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AECOM Project Number:

60145649

Metrolinx Contract Number:

Contract No. RQQ-2009-RI-011

Date:

November, 2011

Executive Summary

Context

GO Transit is known as the Greater Toronto and Hamilton Area's (GTHA) interregional public transportation service. Today, approximately 180,000 passengers commute into the City of Toronto by rail each weekday, most of them living within 20 to 50 km of the city. In late 2008, Metrolinx published a Regional Transportation Plan (RTP) which outlined the long term view of transportation throughout the GTHA. GO Transit followed this work with their GO 2020 strategic plan which set out how GO Transit rail services would grow in the mid-term to develop two-way, all-day service on all seven corridors. As part of this strategy GO Transit recognized that, inasmuch as their rail corridor plans will need expansion, there will also be the need to understand the impact this will have on their central hub of train activity in Toronto, Union Station and the surrounding Union Station Rail Corridor (USRC).

Union Station and Union Station Rail Corridor Capacity Study

GO Transit is in the midst of various USRC and Union Station building modifications. These major changes include the upgrading of the existing track infrastructure throughout the USRC; the upgrading of the signal system to control train movements throughout the USRC; the replacement of the train shed roof; a new communications system; and other operational and infrastructure improvements. GO Transit understood the need to quantify the ability of these changes to handle the expanded train service . GO Transit also recognized that Union Station and the USRC has a finite capacity to handle train movements. This created the need for this capacity study to provide GO Transit with a clear understanding of what the maximum capacity of these facilities could be to handle train movements and therefore how much line expansion in commuter service can be developed before they may need additional downtown Toronto terminal capacity.

Study Scope and Methodology

The study was guided by three directives: determine the capability of the track network within the USRC and Union Station once the current modifications are completed; quantify the full capability of the USRC and Union Station to handle the maximum train service; and look beyond this maximum train capacity and suggest capacity additions which might be further investigated.

The study calibrated the simulation model against the current train service plan operated through the USRC and Union Station. This was followed with the analysis of the 2015 train plan which included the current train service plus the Airport Rail Link (ARL) between Union Station and Pearson International Airport. Following this our study team analysed the Electrification Reference Case level of train service which was proposed to operate through the USRC and Union Station by the Electrification Study. The analysis searched for the maximum capacity capable for train service into and through the USRC and Union Station. Finally, the study the team looked at future additional train capacity possibilities beyond the identified maximum operating capacity of the USRC and Union Station. The results of these analyses will provide GO Transit with a long range outlook for train service, within the USRC and Union Station, which GO Transit can use to guide their growth of commuter train service within the USRC and throughout their system.

Base Case and Development of Test Parameters

Determining train capacity on a given track network is complex as it is not a static system. The system is a combination of a physical track network and a dynamic train plan which depends on the different types of trains and how they operate within the USRC network. The study team employed Berkeley Software's RTC Train simulation package, which is well recognized within the rail industry for its ability to demonstrate realistic train activity and determine train capacities on given rail networks.

The initial task was to calibrate the model by loading the model with the current train plan operated over the USRC and Union Station and the current rail network it operates on. This would generate train performance parameters for all train service types presently operated. With this set of “Base Case” parameters, all other theoretical cases would be tested against them. In this way the future plans for trains and tracks could be tested to see if they can perform at a level which meets or exceeds the current successful performance achieved in the USRC and Union Station.

Today the USRC and Union Station manage 29 arrival trains per peak hour each week day. This number comprises 24 GO trains plus 5 VIA and ONR trains. GO trains operate to and from seven corridors with full-day service on two corridors and peak period, peak direction service on the other five corridors. VIA operates over three main corridors with the trans-continental train operating on alternate days on two additional corridors. CN and the ONR operate one or two trains each day over one corridor and passed the station. Within Union Station train shed presently there exists 14 tracks and 2 run around tracks to the south. Station tracks are allotted as, 9 for GO Service, 3 for VIA Service, 2 out-of-service for roof reconstruction needs, and the two run around tracks. The USRC eastern segment is made up of 8 approach tracks while the western segment is made up of 9 such tracks. This makes up the Base Case of rail traffic and infrastructure within the USRC.

Working with this Base Case of information the study team established a simulation which reflected how the current train service is operated and finalized the calibration of this simulation so that this model reflected how the current rail traffic operates according to the statistics provided. Once this calibration was completed the model reflected the performance characteristics of the actual train service it was modelling. With these parameters now verified, the study team proceeded to evaluate future train service plans operating on revised track networks to assess the capability of these revised plans to perform at an acceptable level. The overall system performance of the USRC was 94.4 % with a randomization factor in the schedules of each train between 0 to 4 minutes late. This parameter of performance at a four minute randomization is the primary test of train service performance.

2015 Train Service Assessment

The Airport Rail Link (ARL) is planned to be put into service in 2015. In addition it is expected that VIA’s train service will have grown due to improvements on the Toronto/Montreal corridor and the Toronto/Stratford/London corridor. The study team was asked to analyse how the USRC and Union Station would perform with the additional peak hour arrival of 4 ARL trains and 2 VIA trains to the Base Case which would generate 35 trains per peak hour for this train service plan. The USRC and Union Station track plan would remain the same as in the Base Case with the only addition being the track upgrades such as the double slip switch replacement, the signal upgrades, the shed roof replacement, etc., completed. The ARL train service will have its own dedicated track at Union Station to operate from and set routing to move between this station track and the Georgetown Corridor. Included in this analysis was the use of all tracks in Union Station including track 15 along with relocating VIA train service from tracks 8 – 10 to tracks 13 – 15. Another significant change added at this point was revising VIA’s station track occupancy for each train to a quicker station stop of 40 minutes for loading and 10 minutes for unloading passengers. This may require servicing of VIA trains to be undertaken elsewhere especially during the peak periods and not at the station tracks.

The analysis indicated that on a system basis this regime of commuter trains would perform better than the Base Case at 96.5% on an equal analysis basis. Even with this overall level of performance the Barrie and Milton commuter train services would under-perform comparatively at 87.5 and 89.2 %. As we learned further along in the study, these poor performances were due to conflicting train movements in the USRC which could be corrected through the changes to the train schedule times for these two corridors, to enable them to access a route into the train station without conflicting with other train services. In this instants these two corridors were conflicting with some of the ARL trains. In this way the USRC and Union Station could handle this increase in traffic with the ARL being directed into one specific station track on the basis that some minor train schedule modifications between trains from different rail corridors would be required to make the trains arrive and depart at Union Station without interfering with other services.

Electrification Reference Case, Train Service Assessment

With the parallel Commuter Rail Electrification Feasibility Study underway at the time of this study, the study team was asked to confirm the ability of the USRC and Union Station to operate the level of train service proposed by the Electrification Reference Case. In direct terms this Electrification Reference Case (ERC_1) consisted of a full day, two way commuter train service on each of seven corridors, along with a long term VIA train service and the ARL all in operation each week day. This would consist of 41 arrival trains per peak hour each week day for GO trains, 7 for VIA and ONR trains, and 4 ARL trains. This would be a total of 52 arrival trains per peak hour each week day through the USRC and Union Station, or approximately double what is managed in 2011. The track network was kept the same as the 2015 Case for this assessment. The analysis initially indicated that for the schedule pattern provided by the Electrification team, this system of trains would perform at 84.4%, with only the Richmond Hill corridor providing an acceptable level of service. As this was not acceptable the study team looked at what could be done to improve the performance to satisfactory levels.

The next analysis was $ERC_{2.}$ Given what we had learned from the ERC_1 simulation, we better understood that train meets in the western segment of the USRC must be kept to a minimum. The long range plan for line corridor train service, calls for a total of 13 tracks approaching the USRC from the west and going into a 10 track limitation in the USRC near John Street then opening up to 15 tracks at the station. In the eastern segment of the USRC the long range has 6 tracks approaching the USRC from the east going into 8 tracks which end up in 15 station tracks. The study team looked at adjusting the train schedules to allow all train services to follow a direct route from each rail corridor to a station track designated for that corridor service in an effort to reduce the cross plant movements and any other interfering train movement within the USRC. The by-product of this analysis required that a number of train meets would need to occur outside of the USRC and this would require rail corridor capacity be developed to manage these changes to train schedules.

The track network was revised at this point to the maximum 10 tracks possible through the western segment of the USRC. Four crossovers were added in the Fort York area to provide direct routing for the Lakeshore West corridor to the station tracks, in association with revisions to the ladder tracks servicing station tracks 10 – 14. In addition, to improve the conflicting movements between the ARL and other train services, a crossover was put in between track A1 & B just east of John Street. In the station area, track 15 was removed and a platform was modelled between track 14 and 16. Generally the eastern segment of the USRC did not present the restricting problems found in the western segment of the USRC. The line corridors in the east are estimated to grow to a total of 6 corridor tracks coming into 8 USRC track and on to 15 station tracks.

The analysis of this revised train plan (ERC_2) indicated; with these changes the train performance went up to 97.5%. This enabled all corridor train services to perform better than the Base Case except Lakeshore West which performed at 93.3%. The solution to improving the Lakeshore West performance was to continue to look at routing train services from each corridor over the same route into the station tracks and continue to reduce conflicts between train services. As all train services occur in space and time, the team needed to look at each time segment and make sure that train routing from the rail corridors to the station tracks was set up with a clean route from the train service corridors to Union Station. The significance of direct train routing is when the train service is uninterrupted, the On Time Performance (OTP) will be high, while during disrupted times the effect on performance will be limited to the line corridor train service disrupted and not other train services. The sensitivity analysis pointed out that this level of train service over the USRC and Union Station is reaching its maximum peak hour service capacity.

As a variation to ERC_2 the team was asked to look at moving the ARL train service from track one to another track. The benefit of doing this was to determine if this move would improve the train routing to and from the Georgetown corridor and improve access to North Bathurst Yard for equipment movements. We used the same train service and track plan as ERC_2 and the performance increased slightly to 97.9%. The impact to each corridor varied but all stayed above the Base Case except Lakeshore West which came in at 93.9%. Given the randomization of each train performance between zero and four minutes late, this alternative (ERC_3) can be expected to be equivalent to ERC_2

and we have found a possible second location for the ARL on track three and better access directly to North Bathurst Yard storage for equipment moves off of track one and two. This assists in removing conflicting cross track movements between equipment and revenue trains which support the ability to maintain train performance.

Issues Learned from Simulations

The results of the full train service simulations were developed on the basis of the use of existing train equipment and performance measures. In addition, as train service levels increased, some of the fundamental parameters must be adjusted to enable successful train performance at each level such as:

1) Increased train service in USRC must be matched with increased approach corridor capacity, driven by train service scheduling.
2) Train routing between approaching corridors and the station must be routed to reduce or eliminate train conflicts.
3) Train meets in the peak periods between trains from the same corridor should be reduced or eliminated within USRC.
4) Equipment train movements into and out of service at the station during peak periods should be routed to reduce or eliminate train conflicts.
5) Eliminate trains crossing over in front of other trains in the USRC during peak periods.
6) Station track dwell times during the peak periods must be reduced for all passenger train services.
7) With the increase in commuter train service, more equipment movements will be converted into revenue trains.
8) With the increase in commuter train service, equipment movements in the peak periods will need to follow the flow of trains onto the approaching corridor and travel to a storage location adjacent to that corridor.
9) Train storage at Bathurst North Yard and Don Yard can only handle train movements in and out during off-peak periods.

GO Transit will need to work with VIA and ONR to reduce their dwell times at the platform tracks during peak periods for unloading and loading of intercity passengers. One of the significant issues is time required at the station tracks to service these intercity trains during the peak periods and where else this work can be done other than at the station tracks.

Other Capacity Issues

The study team also looked at what effect changes to the movement of trains through the USRC and Union Station would have on these levels of train service.

Impact of Electrification on USRC Train Service

We reviewed the positive impact of the increased tractive effort available through the use of electric locomotives and determined that within the USRC the benefits are minimal. We found that electrified trains would have quicker starts and stops for each train but given the 6 km length of the USRC and the one planned stop within these limits, the electrification of commuter trains would have approximately a 3.5% improvement in run times or 16 seconds in a 7minute 23 second run time. This can be attributed to the relatively short length of the USRC and the speed restrictions limiting the increased acceleration capabilities of the electric locomotives. Interestingly the benefit of the electric locomotives increased as the number of trains approached saturation. This can be attributed to unscheduled stops by trains within the USRC while waiting for their route to become clear. The electrification should provide better recovery during major service disruptions.

Value of Through vs. Double Berthing of Trains at Union Station

Two distinct types of station train stops were looked at to find out if either of these would improve train capacity in the USRC and Union Station. One method of station stop is the Through Train, which is a train that is destined to go through the station from one corridor to another with a stop at Union Station to depart or load customers. The second method is the Double Berthing train plan which is two trains arriving at the same time on the same station track, each from the opposite direction and occupying one half of the station track and then departing back in the same direction it arrived from. The Double Berthing train plan would occupy the station track with two trains for about 15 minutes while the Through Train would occupy the station track with one train for about 10 minutes. The Double Berthing plan could provide for 8 trains per hour while the through train plan could provide for 6 trains per hour.

At present Union Station can offer the possibility of Double Berthing on tracks 6, 7 & 8 out of the 15 station tracks. For these tracks they could accept 33% more trains per hour. This raises the issue of managing the movement of an increased number of commuter patrons to and from these trains and whether this increase in trains and patrons is manageable at that point.

The results of this assessment indicates that through train movements will make the best use of USRC track capacity and will create a level of passenger flow which will need to be studied. On the other hand Double Berthing will allow more trains at the platform and possibly more time for passenger flow but will reduce the maximum number of trains managed in the USRC in a peak period. This creates the need for a trade-off between these two train operation possibilities as well as a closer look at how to manage the movement of patrons between the station concourse and the trains within the time provided by each train service type. The passenger management analysis portion of this understanding will need to be taken up by others.

Train Capacity Future beyond USRC Maximum

We looked at two probable alternatives to adding capacity and allowing train service capacity to grow beyond the maximum capacity of the current USRC infrastructure. One option was to establish a new station under the current Union Station but offset to the east between Bay Street and Yonge Street. This would allow the Lakeshore East and West rail traffic to be relocated by tunnel to this new below ground station and provide for the possible increase in commuter train traffic in the order of 30% at an approximate cost of $1.3 Billion. On the other hand this may pose difficulties managing the people movements for commuters who would use this system as they move from the train system into and out of the Central Business District of Toronto (CBD).

The second alternative would be to create a stub end satellite station terminus for the Barrie and Georgetown train services in the current Bathurst North Yard area. This proposal would be much less expensive than the tunnel option with an approximate cost for a basic station of about $75M, but may require additional effort to enable the ridership to move between this area and the downtown work locations or the subway. If the City develops additional subway capacity which may service this location, then this would provide a very acceptable commuter train service for these commuters. From a train traffic point, this would remove approximately 20% of the commuter train traffic from the current station and allow the traffic from the other corridors to grow. A variation of this could be to tunnel these trains into the Union Station area and stub end these services there.

Neither of these two possible expansions has undergone any level of engineering assessment or traffic simulation. The suggestions provided are the most probable solutions to develop more train capacity for commuter train service into the CBD. These probable costs provide a measure of magnitude only and could be considerable higher as there are significant challenges, particularly for property at the tunnel entrance and exit points. Should any of these items be worthwhile pursuing, we recommend a further engineering and feasibility study be undertaken to narrow the understanding of what will be required to implement the changes.

Conclusion

This study presents GO Transit with a number of realities and points which will provide guidance during the growth of commuter train service over the next many years.

1) Union Station has a limited number 15 station tracks and expansion beyond this must be elsewhere.
2) USRC and Union Station capacity is largely controlled by:
    a. A 10 track limit in USRC western segment near John Street
    b. The approach corridors' capability to manage train meets prior to entering the USRC.
3) Station Track Dwell times for all passenger train service must be kept to a minimum during peak periods.
4) The existing train service plans have many trains arriving at the same time.
5) With growth of train service, routing of trains from corridors to station tracks must be developed to put trains on specific direct routes which do not cross with other routes.
6) Peak hour train capacity can be doubled through the USRC and Union Station with a number of track interconnections added.
7) Total train capacity operated in the USRC and station can be tripled as commuter traffic grows to full service.
8) Cross plant train routing in USRC during peak periods must be reduced or eliminated as traffic grows.
9) The use of Bathurst North Yard and Don Yard during peak periods needs to be reduced and eliminated as train service grows.
10) During peak periods equipment movements in and out of Union Station will need to follow the flow of trains onto the adjacent corridors and find storage sites on these corridors.
11) Scheduled use of Bathurst North Yard and Don Yard needs to be carefully determined for non-peak times.
12) Double Berthing vs. Through Train strategies, trade-off the greater USRC train management capability of Through Train operations versus the increase of commuters delivered to the station with a lesser level of train service ability managed by the USRC.
13) Electrification of trains will have a minimum impact on the speed to manage trains and improve the ability to manage disrupted train service in the USRC.

In summary, the USRC and Union Station will reach its maximum train operations capacity during the peak periods at the point when all seven train service corridors are operating a full day train service. This will require relatively few modifications to the interconnections of the track network within the USRC. The total daily volume of train service can be expected to increase by approximately 3 times the present volumes operated while the peak hour volume will increase by approximately two times the current train traffic handled. On the way to reaching these volumes, GO Transit will need to revise the handling of conflicting train movements within the USRC by direct routing train services to the appropriate station track, by eliminating equipment movements between the station and Don Yard or Bathurst North Yard during the peak periods and by adjusting the various corridor train schedules to dovetail these services in their operation through the USRC to Union Station.

This report has also looked at how electrification will have some minor beneficial effects on train service and how there may be a trade-off between the benefits of Through Train vs. Double Berthing of trains which will need to be considered at various stages of growth. Lastly, this report points to two probable solutions to developing some additional train service capacity beyond the maximum capabilities of the USRC and Union Station. There is the possibility of a subterranean set of approach tracks below the USRC corridor and an additional station located to the east of the current Union Station which, when added to the capacity managed by the USRC, could total approximately 90 trains per peak hour. Separately there is the probable case that could be made for a terminus station to be established in the Bathurst North Yard location which could handle the commuter traffic from the Barrie and Georgetown corridors. This satellite station has the possible promise that when added to the capacity managed by the USRC could total approximately 80 trains per peak hour. This location and commuter traffic could draw the city of Toronto's Central Business District towards the west, especially if this station can be linked up with a revised Downtown Relief Line TTC subway which could pass below this site on its way to the Exhibition grounds.