



Line 1 Capacity Requirements - Status Update and Preliminary Implementation Strategy

Date: April 11, 2019
To: TTC Board
From: Chief Capital Officer

Summary

Line 1 Yonge-University is the busiest rapid transit line in Canada. With more than 730,000 riders each weekday, the line plays a crucial role in moving people in Toronto and in the Greater Toronto region. It is closely integrated into the TTC network of surface routes, making more than 100 connections and interchanges seamlessly with regional services at 13 stations.

Ridership on Line 1 has been growing consistently over the last 15 years, all along the line. At the busiest point on the line, south of Bloor-Yonge Station, morning peak ridership has reached maximums of 28,000 to 30,000 people per hour in the peak direction. This is in line with the current capacity of the service.

Increases in ridership are mainly as a result of population and employment growth. Continued growth, along with planned transit expansion projects, is driving forecasted future ridership demand even higher. Current plans will permit modest increases in capacity over the next few years, until approximately 2026. After that point, the continued increase in ridership demand will introduce concerns for the continued safe, reliable, and effective ability of Line 1 to serve transit customers.

In order to address these concerns, the TTC is undertaking a Line 1 Capacity Requirements Study, in collaboration with regional and municipal partners. The study is a comprehensive assessment of future expected demand. The study is assessing the changes to subway trains, stations and facilities, signals, electrical power, maintenance procedures, and operating strategies, including staffing, that will be required to meet the ridership demands. The work takes a system-wide approach, and is focused on delivering upgrades in four horizon years between 2021 and 2031 to meet the projected demands. The plan will recommend clearly defined, costed, and deliverable projects, many of which are interrelated. Through its implementation, the program builds upon improvements already made or underway on the line, such as the introduction of new, higher-capacity trains and the installation of the Automatic Train Control (ATC) signal system, and adds to other key elements that are required to plan for and deliver increased capacity in a systematic way. The ultimate goal is to deliver a capacity that accommodates the projected ridership demand.

A failure to deliver the necessary capacity on Line 1 will have serious effects on the transit system throughout Toronto. If the line ridership regularly exceeds capacity, the quality of the transit service will decline. Delays will become longer and more common. Customers at some stations will be unable to board trains at busy times. Crowding in stations and on trains will increase. Without increasingly proactive operational measures, such as temporarily closing stations to passenger entry and bypassing of crowded stations by trains, the safety of customers could be compromised by the mid-2020s. Ridership will decline, trust in the transit system will be damaged, and the wider economic and social benefits of a well-functioning transit service will not be fully achieved.

This report provides an update on the preliminary stage of the Line 1 Capacity Requirements Study, and will be the first of several reports to the Board providing periodic updates on this major undertaking.

Recommendations

It is recommended that the Board:

1. Endorse the Line 1 Capacity Requirements - Status Update and Preliminary Implementation Strategy, as described in this report, and the next steps to continue to define the requirements to achieve capacity improvements and accommodate forecast demand;
2. Direct staff to report back to the Board at Stage-Gate 1, no later than Q3 of 2020, with a preliminary Business Case, updated preliminary cost estimate and schedule;
3. Forward this report to the City Manager for consideration and integration into the City's 2020 Capital Planning and Budget Process and Long Term Fiscal Plan;
4. Forward this report to the Chief Administrative Officer at the Regional Municipality of York to support discussions on Line 1 capacity requirements and for consideration in their Capital Planning and Budget Process; and
5. Forward this report to the Province for consideration in their study and planning processes.

Financial Summary

Partial funding for this program is included in the TTC's 2019 – 2028 Capital Plan approved by Council on March 7, 2019 in the following projects:

- Line 1 Capacity Enhancement;
- Bloor-Yonge Capacity Improvements Conceptual Design & Alignment;
- New Transit Control – ITS Centre;
- Fire Ventilation Upgrades – College Station Second Exit;
- Station Capacity Study for Increased Passenger Demand; and
- TR/T1 Rail Yard Accommodation – Wilson Yard Train Access Platforms.

Funds in the amount of \$2 million for the implementation of the 2019 work plan are included in the approved 2019 Capital Budget – Project No. 3.9, Line 1 Capacity Enhancement.

Preliminary costing for Line 1 was identified for planning purposes within the Capital Investment Plan. High level cost estimates totalling nearly \$9 billion were identified for various project components including Line 1 Capacity Enhancements, vehicles, northern yard, Bloor-Yonge station, remaining ATC costs, System-wide Platform Edge Doors, Transit Control Centre and various other projects either currently underway or about to commence. Aside from funds approved to complete Line 1 ATC, and for initial program work, the Line 1 Capacity Requirements are predominately unfunded.

Additional funding for the implementation of the strategy for this major program will be included in future year budget submissions annually supported by business cases and periodic updates to same. Subsequent Board reports will include updates on the progressive development of cost estimates through the capital project Stage-Gating process for the various key elements.

The Chief Financial Officer has reviewed this report and agrees with the financial impact information.

Equity/Accessibility Matters

A cornerstone of the TTC's Corporate Plan 2018-2022 is accessibility, and as a proud leader in providing accessible public transit in the city of Toronto, we are committed to ensuring reliable, safe and inclusive transit services for all our customers. This is supported through the continued work of the Line 1 Capacity Requirements - Status Update and Preliminary Implementation Strategy.

The TTC is working toward achieving a more inclusive and accessible transit system that meets the needs of all of its customers.

Decision History

This work aligns with the following previous reports to the Board:

At the Special City Council Meeting on March 7, 2019, City Council approved the TTC's 2019 – 2028 Capital Budget:

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2019.EX2.5>

At its meeting on January 24, 2019, the TTC Board approved the TTC 15-Year Capital Investment Plan & 2019 – 2028 Capital Budget & Plan:

[http://www.ttc.ca/About the TTC/Commission reports and information/Commission meetings/2019/January 24/Reports/10 TTC 15 Year CIP 2019 2028 Capital Budget.pdf](http://www.ttc.ca/About%20the%20TTC/Commission%20reports%20and%20information/Commission%20meetings/2019/January%2024/Reports/10%20TTC%2015%20Year%20CIP%202019%202028%20Capital%20Budget.pdf)

At its meeting of May 8, 2018, the TTC Board approved the report titled “Capacity Improvements on Bus and Subway Services” which outlined capacity improvements including improvements to service reliability on Line 1:
[http://www.ttc.ca/About the TTC/Commission reports and information/Commission meetings/2018/May 8/Reports/7 Capacity Improvements on Bus and Subway Services.pdf](http://www.ttc.ca/About%20the%20TTC/Commission%20reports%20and%20information/Commission%20meetings/2018/May%208/Reports/7%20Capacity%20Improvements%20on%20Bus%20and%20Subway%20Services.pdf)

At its meeting on February 15, 2018, the TTC Board approved the report titled “Events of January 30, 2018 on Line 1”, outlining the need to add capacity across the network and reduce overcrowding in the system:

[http://www.ttc.ca/About the TTC/Commission reports and information/Commission meetings/2018/February 15/Reports/19 Events of January 30 2018 on Line 1.pdf](http://www.ttc.ca/About%20the%20TTC/Commission%20reports%20and%20information/Commission%20meetings/2018/February%2015/Reports/19%20Events%20of%20January%2030%202018%20on%20Line%201.pdf)

Issue Background

As ridership demand on Line 1 reaches its current capacity, the forecast demand will further strain the system leading to further crowding, a reduction in reliability, and potential safety issues for transit customers.

Today, Line 1 has an average daily weekday ridership of over 730,000 riders, making it the busiest rapid transit line in Canada. Currently, the modelled demand southbound from Bloor-Yonge station during the AM weekday peak hour is 28,300 passengers per hour per direction (pphpd). The present capacity however, is limited to 28,000 pphpd, and by 2031, the demand is forecast to grow to 36,000 pphpd. This projected growth is an increase of approximately 30%.

Impacts on ridership demand are mainly as a result of population and employment growth, as well as transit expansion projects and future transit initiatives. While some future projects will increase demand on Line 1, others are expected to reduce demand. The planned or committed projects that would increase demand on Line 1 because of increased ridership are: Line 5 Eglinton, between Kennedy and Mount Dennis; Line 2 East extension, from Kennedy to Scarborough Centre; and Line 1 Yonge Subway Extension (Yonge North Extension), from Finch to Richmond Hill. Projects that would reduce demand or relieve capacity constraints on Line 1 include: GO Fare Harmonization and SmartTrack, which would attract customers to GO trains instead of the TTC system; Automatic Train Control (ATC) on Line 1, which will improve the reliability of the signal system and allow more frequent service to be operated; Bloor-Yonge Station Capacity Improvements project which would accommodate passenger and transfer growth at that station; and the Relief Line South subway, from Pape Station to Osgoode/Queen which would attract customers to the new Relief Line from Line 2 and Line 1.

Significant improvements to help increase Line 1 capacity have already been undertaken. In recent years these include:

- A new fleet of Toronto Rocket (TR) subway trains that was put into service as of 2015. These six-car trains have an open design that enables passengers to move freely from one end to the other, providing an approximate 10% increase in capacity;
- ATC signal upgrade that is underway, and is currently in service from Vaughan Metropolitan Centre (VMC) station to Dupont station (40% of Line 1). ATC provides increased service reliability and allows for more frequent service, as compared to the previous signal system;
- Improved station management, with additional TTC staff on the platforms directing and assisting customers;
- Customer awareness campaigns about subway service levels and subway etiquette; and
- Extra 'run-as-directed' trains that are used when necessary to fill gaps in service.

In recent months, the southbound morning peak service at Bloor-Yonge Station has been able to exceed the scheduled average 25.5 trains per hour as a result of improved station management, and operational adjustments including the early benefits of the ATC project implementation. However, in order to meet the continued growth in demand and corresponding future target capacities, a coordinated plan to address sustained capacity shortfalls is required.

A failure to deliver the necessary capacity on Line 1 will have serious effects on the transit system throughout Toronto. If the line regularly exceeds capacity, the quality of the transit service will decline. Delays will become longer and more common. Customers at some stations will be unable to board trains at busy times. Crowding in stations and on trains will increase. Without increasingly proactive operational measures, such as temporarily closing stations to passenger entry, and bypassing of crowded stations by trains, the safety of customers could be compromised by the mid-2020s. Ridership will decline, trust in the transit system will be damaged, and the wider economic and social benefits of a well-functioning transit service will not be fully achieved.

Comments

In the third quarter of 2018, at the request of the CEO, staff were directed to: identify issues constraining Line 1 subway capacity; undertake a needs analysis to determine shortfalls in various elements; and explore solutions to accommodate forecast demand growth. A Program Management approach was adopted, to manage the interrelated elements in a coordinated way, in order to enable increased capacity to accommodate demand.

Study Background

The study began with ridership demand forecasts that were provided by City of Toronto and TTC staff, using the latest projected employment and population statistics, and planned future transit projects. These forecasts of future ridership on Line 1 were used to establish target capacities for this study, which slightly exceed the projected ridership to allow for variation in estimates and actual operation. The resulting required service levels were then determined, in order to meet the target capacities. These were set for four future horizon years, 2021, 2023, 2028, and 2031, which predominately correspond

with the opening of significant connecting transit lines, and other initiatives. The 2031 year was used as a base for long term ridership forecasting. Table 1 shows the projected peak demand on Line 1, the target capacity, and the resulting required service levels, expressed in both trains per hour and the time between scheduled trains (headway).

Table 1: Service Capacity Targets by Horizon Year

Horizon Year	Projected Demand morning peak (pphpd)	Required Target Capacity to meet Projected Demand (pphpd)	Required Service Level to meet Target Capacity	
			Trains per hour	Scheduled interval (headway)
Today	28,300	28,000	25.5	2 ' 21 " (141 sec)
2021	31,500	33,000	30.0	2 ' 00" (120 sec)
2023	32,700	34,400	31.3	1 ' 55 " (115 sec)
2028	34,040	36,000	32.7	1 ' 50 " (110 sec)
2031	36,000	37,700	34.3	1 ' 45 " (105 sec)
beyond 2031	37,700	39,600	36.0	1 ' 40 " (100 sec)

1. Target capacity based on AM peak hour demand southbound from Bloor station.
2. Target capacity based on Board approved crowding standard of 1,100 passengers per train.
3. pphpd – passengers per hour per direction.

These target capacities will achieve a throughput of over 31 trains per hour targeted for 2026, the mid-point of the study period, and an ultimate goal of 36 trains per hour by 2031. For the years beyond 2031, work is being done by Metrolinx, in conjunction with the TTC, the City of Toronto, and York Region, on a Line One Demand and Network Capacity (LODNC) study on future requirements, with a final report anticipated in Q4, 2019.

Study Objective and Key Elements

Given the known issues about future capacity, and the development of the future projected demand and related target capacities, a project objective was developed:

Identify issues constraining capacity on Line 1 and develop an implementation strategy to achieve service capacity targets for 2021, 2023, 2028, and 2031 horizon years.

To deliver this objective, a project team was established, and external consultant assistance and was retained to provide support for the assessment of shortfalls and development of a preliminary implementation strategy. Through information gathering sessions and workshops with key stakeholders, 19 key elements that constrain capacity on Line 1 were identified for assessment. These are listed in Table 2.

Table 2 - Description of 19 Elements

Elements	Key Issue Description
Terminal Station Turn Back	Current Vaughan Metropolitan Centre and Finch Station turn back track configurations / procedures can result in increased run and dwell times, which impact train headways.
Bloor-Yonge Station	Station capacity is constrained as a result of limited platform area on Line 2, and inadequate vertical circulation and egress, which can lead to increasing dwell times and train headways.
Station Capacities	As service levels increase, there may be more stress on stations and associated vertical circulation elements as the interval between train arrivals is shortened. Limited station space, platform area and vertical circulation/ exit options can impact the ability of all customers to leave the platform before the next train arrival, affecting station dwell time and headways.
Manage Station Dwell Times	Excessive dwell times and large variations in dwell times can impact service capacity targets during peak hour service. The project will identify top priority stations that need to be addressed first.
Electrical Traction Power	Existing electrical traction power infrastructure may not be capable of supporting the increased power demand associated with increased trains operating on the network, while still providing redundancy for maintenance and resiliency.
Fire Ventilation Requirements	Increased service frequency will increase the number of trains in the tunnels which can result in more trains within a ventilation zone, potentially requiring system upgrades.
Automatic Train Control	Delays in the completion of the ATC re-signalling implementation could prolong an existing signal system capacity limitation that prevents trains from operating at the reduced target headways that are, and will be, necessary to meet the future target demand capacities.
Additional Trains	As subway service becomes more frequent to meet the target capacities and the subway network is extended, there are not enough trains in the current fleet to deliver the future service requirements.
Additional Train Storage	As the fleet grows to meet the target capacity, additional track space will be required to store trains during non-revenue hours. Also refer to the fleeting element, below.

Elements	Key Issue Description
Carhouse Maintenance Capacity	As the fleet increases to meet the target capacities, the existing carhouses will not be capable of supporting the maintenance requirements to ensure safety and reliability.
Transit Control Centre Capacity	The Transit Control Centre consists of critical infrastructure, and communication networks required to operate the transit system. It will need to be upgraded / expanded to accommodate the increasing system demand.
Managing Higher Frequency Service	Existing operating procedures and practices will need to be reviewed and updated, as required, to meet the increased ridership demand, more frequent service, higher volumes of passengers, and increased number of trains.
Platform Edge Doors	Platform Edge Doors may be used to help sustain high frequency service by reducing the frequency of track level incidents and accidents including suicides, and better organizing passenger boarding and alighting, and thereby increase service reliability.
Asbestos Abatement	The ongoing asbestos abatement program in the subway tunnels is required to facilitate installation of ATC infrastructure and may preclude other critical maintenance activities to be completed to maintain or meet future system capacity targets.
Tunnel Liners	The integrity of the pre-cast concrete tunnel liners is critical to TTC's ability to operate the system safely and sustain target capacities. As tunnel liners continue to deteriorate, the repair program needs to be prioritized.
Additional Staffing	As service increases to meet growing demands on Line 1, it will be necessary to acquire staffing to support operational, maintenance and capital needs.
Track Geometry / Maintenance	Higher frequency service along Line 1 will result in increased track wear maintenance needs and more frequent component replacement.
Maintenance Window	A non-revenue service window of time is required to implement necessary repairs and maintenance activities on the subway and will be impacted as service is increased and more trains must enter and leave service.
Fleeting of trains into service	As more trains are required for service to meet increased service demand, the existing storage locations may not be capable of properly dispatching trains onto the main line at the required rate, without impacting the existing maintenance window.

Shortfall Analysis

While all key elements are integral and need to be further investigated, 13 of the 19 elements have been identified as having a direct impact to improving capacity. Direct elements are those whose impact to capacity can be quantified, and addressing them is necessary to achieve the target capacities. Indirect elements are not likely to constrain capacity; however, they may impact the ability to sustain capacity.

In order to address the preliminary work required, a comprehensive list of enhancement options for each element was developed. The options were categorized based on feasibility and likelihood, and yielded a set of proposed improvements for each element's constraints at the various target horizon years. Through workshops and analysis, a preliminary implementation strategy, high level costing and critical timeline interdependencies were developed, based on the selected proposed options.

Table 3, below, summarizes the proposed preliminary key enhancements identified for each element at associated target horizons, and also whether each element has a direct or indirect impact on capacity. All elements are required to deliver increased capacity, and the detailed work required for the enhancements will be further validated as part of this project. Work on some of these enhancement has already begun and is contributing to improved capacity, including the management of station dwell time and the ATC project.

Table 3: Identified Enhancements by Element and Target Horizon Year

Element / <i>Direct or indirect effect on Capacity</i>	Enhancement Options				
	2021 (120 sec)	2023 (115 sec)	2028 (110 sec)	2031 (105 sec)	Beyond 2031 (100 sec)
Terminal Station Turn Back <i>Direct</i>	-Provide additional staff training to reinforce operation -Add service assist crews to reduce delays in dwell times				
Bloor Yonge Station <i>Direct</i>	-Implement operational strategies (staff, stanchions, marking arrows, exit only trains) to streamline passenger movements -Develop station signage and wayfinding strategy during Bloor Yonge construction		-Completed construction of the major expansion project		
Station Capacities <i>Direct</i>	-Implement operational strategies (staff, stanchions, and marking arrows) to streamline passenger movements -Expand analysis, passenger modelling and design investigation to address future target horizon years demand	-Same as 2021, and -Enhance station wayfinding and signage	-Implement station enhancements (additional vertical circulation elements, second exits) at priority stations (e.g. King, Dundas, College, St George, St Andrew and Queen's Park Stations)		

Element / Direct or indirect effect on Capacity	Enhancement Options				
	2021 (120 sec)	2023 (115 sec)	2028 (110 sec)	2031 (105 sec)	Beyond 2031 (100 sec)
Manage Station Dwell Times <i>Direct</i>	-Implement operational strategies (staff, stanchions, marking arrows, exit only trains, targeted announcements) to streamline passenger movement -Develop station signage and wayfinding strategy during Bloor Yonge construction	-Same as 2021, and -Enhancements to wayfinding and signage (media wall, LED strip) at priority stations			
Electrical Traction Power <i>Direct</i>	-Improve resiliency conditions -Increase capacity of electrical system				
Fire Ventilation Requirements <i>Direct</i>	-Review and update emergency procedures to coordinate fire ventilation, train control and traction power		-Provide new fan plants at St Clair West and Eglinton West station, and upgrade fans at Markdale, Glenayr, and Russell Hill Emergency Service Buildings	-Upgrade fan plant at Lytton Emergency Service Buildings	
Automatic Train Control <i>Direct</i>	-Conduct field testing and coordinate with Open Track simulation model – Q4 2022				
Additional Trains <i>Direct</i>	-Reduce overall runtime, dwell times, spare ratio and adjust service route profile as required -Procure additional trains with delivery commencing in 2026		-Complete delivery of additional trains		

Element / Direct or indirect effect on Capacity	Enhancement Options				
	2021 (120 sec)	2023 (115 sec)	2028 (110 sec)	2031 (105 sec)	Beyond 2031 (100 sec)
Additional Train Storage <i>Direct</i>				-Complete construction of three train storage tracks at Davisville and store one additional train at Finch	-Complete construction of new storage yard near Richmond Hill as part of Yonge Subway Extension and co-locate with new maintenance facility
Carhouse Maintenance Capacity <i>Direct</i>	-Revise business practices to accommodate increased fleet size until new facility is constructed -Commence design and construction of new Heavy Repair & Overhaul Shop at Wilson Yard				-Complete construction of new carhouse preferably near Richmond Hill and new storage yard
Transit Control Centre Capacity <i>Direct</i>			-Complete construction of new primary Transit Control Centre at a new location		
Managing Higher Frequency Service <i>Indirect</i>	-Add Customer Service Assistants at priority stations -Automate system to track delays -Consider adding trains to the fleet to enhance resiliency -Implement reliability-centered maintenance				
Platform Edge Doors <i>Indirect</i>	-Defer recommendations to install Platform Edge Doors (PEDs) pending results of PEDs study in 2020				
Asbestos Abatement <i>Indirect</i>	-Extend current maintenance window -Accelerate Automatic Train Protection on workcars and Line 4 trains.				
Tunnel Liners <i>Indirect</i>	-Extend current maintenance window -Develop tunnel liner replacement strategy				

Element / Direct or indirect effect on Capacity	Enhancement Options				
	2021 (120 sec)	2023 (115 sec)	2028 (110 sec)	2031 (105 sec)	Beyond 2031 (100 sec)
Additional Staffing <i>Direct</i>	-Recruit and train additional staff as needed		-Incorporate training facilities into any new facilities		
Track Geometry and Maintenance <i>Indirect</i>	-Address root cause of Restricted Speed Zones at Rosedale, Summerhill, Glencairn, and Lawrence West by replacing subsurface and installing direct fixation for track -Optimize maintenance practices and evaluate the need to extend the existing maintenance window				
Maintenance Window <i>Indirect</i>	-Construct a new subway infrastructure storage yard and facility in area of Wilson yard -Construct additional workcar storage tracks at Davisville Yard -Evaluate extending the maintenance window by ending revenue service earlier -Modify procedures to allow workcars to bypass hostler at Wilson Yard -Equip workcars with Automatic Train Protection				
Fleeting of trains into service <i>Direct</i>	-Add Subway Yard Operators to minimize delays at hostlers -Reconfigure trackwork to add capacity to north hostler platform -Modify infrastructure and procedures to allow operators to board trains in the yard -Review feasibility of implementing Automatic Train Operation at yards				

Of all of these enhancements, additional trains are particularly essential to realize headway improvements. New trains are required to introduce additional service to reduce headways and increase capacity. Additional trains are also required increase the availability of spare trains to address maintenance requirements and to accommodate mid-life overhaul starting in 2026. Procuring new trains requires the engineering and procurement process to commence by 2020, in coordination with the annual fleet plan, for train delivery to begin no later than 2026. If additional trains are not available in time, capacity will be constrained.

Key Next Steps – Preliminary Implementation Strategy

Given the preliminary timelines for implementation of the Program, it will be critical to perform the necessary additional analyses to develop the appropriate Business Cases. Activities for further investigation include: additional rail network simulation and modelling, minimum headway assessments, passenger flow modelling for priority stations, property identification studies, as well as additional modelling for traction power and fire ventilation. The commencement of the implementation strategy includes the following, with support and involvement from a broad range of internal TTC and external stakeholders:

- Perform pilots, modelling, simulations and additional investigations;
- Refinement of needs assessment;
- Implementation and assessment of operational strategies;
- Preliminary property assessment and monitoring of suitable properties;
- Continuous implementation of risk management activities (risk identification, and response planning);
- Periodic peer reviews;
- Determine interdependencies with other planned TTC subway maintenance and expansion projects;
- Coordination with Metrolinx Line 1 Demand and Capacity Network Study (LODNC);
- Refine the concept of operations, which will define how the system will be operated to meet intended goals, based on a comprehensive analysis of system requirements;
- Establish program scope baseline; and
- Prepare Business Case (including Program Stage-Gating to define future decision points by the TTC Board).

Potential Long-Term Options Beyond 2031

Other opportunities to achieve the long term target capacities include consideration of longer trains, demand management to better spread the demand across the transit network and across peak periods, fare changes, and an additional north-south transit line, after the Relief Line North. The Line 1 Capacity Enhancement report will include a recommended approach for future work on these, and other, options.

Summary

The Line 1 Capacity Requirements and Preliminary Implementation Strategy work is underway. The plan has identified key elements and associated requirements to achieve service capacities at target horizon years, along with high level cost projections, and critical timeline interdependencies.

This ongoing program is essential to evaluating future improvements in a system context and in conjunction with regional and municipal partners. Further update reports will be presented to the Board as work progresses.

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