Surface LRT Operation in Downtown Calgary

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This paper deals with the operation of the Calgary light rail transit line called "C Train" in the downtown area. The line operates for approximately 1 km (0.6 mile) on a standard street that it shares with a peak-hour volume of more than 100 buses. The limitations of this shared roadway system and the special operating rules for both bus and C Train are explained. The effects on the suburban bus system and the interface between feeder buses and the C Train are explored. The paper discusses the reasons for selection of the surface lane on 7th Avenue and the designation of 7th Avenue as a transit and pedestrian mall.

Calgary's C Train line is 12.5 km (7.5 miles) long and runs for most of its length within the right-of-way of the main line of the Canadian Pacific Railway. Once the line leaves the railroad right-of-way it enters a 700-m (2280-ft) tunnel emerging at the south side of the Stampede Grounds. After crossing the Stampede Grounds the line enters a 470-m (1545-ft) tunnel to cross beneath the main Canadian Pacific Railway line, which runs along the south side of the downtown core in an east-west direction.

The line emerges from the tunnel and enters the intersection of 7th Avenue and 3rd Street S.E. at a 45-degree angle. The line then proceeds along 7th Avenue at grade to a terminal at 7th Avenue and 8th Street S.W. This on-street portion of the line is 1 km (0.6 mile) long.

The operation of a light rail line on a downtown street presents a unique challenge and unusual operational problems. The special operating rules for both the C Train and buses on 7th Avenue are discussed in detail, along with the special road markings and signing.

BACKGROUND

The Downtown Master Plan for Calgary (CALTS, April 1976) designated 7th Avenue as a transit mall and a pedestrian corridor. There were two major factors in this decision:

1. There would be no benefit to including 7th Avenue as a major roadway in the downtown system because it lacks suitable connections with other east-west roadways.
2. Large volumes of pedestrian traffic made a major pedestrian corridor necessary in downtown.

Three alternatives considered for the provision of LRT on 7th Avenue were elevated, subway, and surface. The surface operation was chosen because of its lower capital cost and superior pedestrian access.

Nine stations are located on 7th Avenue. Important features of the stations are

- Access to the intersections at each end of the station,
- Access to Calgary's overhead ("+15") pedestrian system, (a "+15" is an elevated pedestrian walkway across a street between buildings that is approximately 15 ft above the roadway and interconnects many downtown buildings, thus allowing pedestrians to reach their destinations in comfort and safety),
- Use of extensive glazing and curved forms to reduce the apparent bulk of the stations,
- Offset loading locations to distribute passengers over the length of the station, and
- Space for accumulation of passengers for peak-hour and special-event loading.

The stations are spaced approximately 3 blocks apart, with bus stops located in the adjacent blocks. A major bus/LRT interface is at 1st Street West, approximately at the midpoint of the 7th Avenue section; this is the timed transfer point for the downtown area.

SURFACE LRT OPERATION ON 7TH AVENUE

The operation of both buses and light rail vehicles on a standard downtown street presented many unique operational problems for Calgary Transit. Bus and C Train movements on 7th Avenue are controlled by a standard traffic signal system; i.e., there is no preemption for the C Train. Some of the problems and the solutions used to overcome them are discussed in the following.

C Train Operational Challenges

North Tunnel Portal

Trains exiting the north tunnel are in immediate conflict with pedestrians, eastbound buses turning left, and southbound buses turning onto 7th Avenue to go west.

The following solutions were developed. For pedestrians, a special crosswalk and signs were put in place. A special traffic signal governs C Train entry onto 7th Avenue, and a signal phase was added to allow the C Train to enter 7th Avenue while all other traffic is stopped. Eastbound buses are stopped at a special stop line approximately 5 m (15 ft) west of the standard location. Buses are prohibited from entering 7th Avenue on a red light. (Right turns on a red light are permitted in Alberta provided the vehicle comes to a complete stop first.)

Pedestrian-Train-Bus Conflicts

The problem of jaywalking pedestrians presents a safety hazard both to themselves and to the trains and buses. The solution involved placement of special "Do Not Jaywalk" signs, a high level of police enforcement, increased fines, and a 40-km/hr (25-mph) speed limit for buses and trains on 7th Avenue.

Signal Progression

The normal method of signal progression based on a vehicle's maintaining a speed that ensures a series of green lights would not work because the C Train was required to stop at all stations.

The solution was to install a computer-directed signal controller that "interlocks" traffic signals, so that once the train leaves a station it receives green lights to the next station.

Intersections

Trains proceeding through a green light did not clear the intersection during the green phase. This resulted in delay of automobile and bus traffic on cross streets.

The solution was to instruct C Train operators to proceed only on a "fresh" green light—that is, a green light shown in conjunction with the pedestrian "walk" indicator.

Another problem at intersections occurred when a 3-car train that stopped westbound at the 4th Street West intersection or eastbound at the 3rd Street West intersection would overlap about 5 m (15 ft) into the preceding intersection.

To solve this problem, the 3rd Street S.W. and 4th Street S.W. traffic signals were interlocked to present a single green phase to avoid having trains blocking the intersection.

8th Street West Terminal

A problem arose at the 8th Street West terminal when the crossover movement of the train from the westbound to the eastbound track created a potential conflict with both eastbound and westbound buses.

As a solution, a "center" line was painted to the outside of the eastbound track. Buses must stay to the north of this line. If a train is at the eastbound 8th Street West platform, buses may pass the stopped train. A cross-hatched area was painted in front of the platform. When a train is in this area, the bus may not pass the train. Thus, when a train is ready to leave, the operator pulls into the cross-hatched area and is given the right-of-way over the buses.

Special Operating Rules for 7th Avenue

Because of the great possibility of conflict between the two transit modes on 7th Avenue, special operating rules for both buses and trains became necessary. The following summarizes the main deviations from normal operating rules.

Bus

1. Buses may not overtake and/or pass a C Train moving in the same direction as the bus while on 7th Avenue with the exception of a C Train that is in the 8th Street S.W. station.
2. Buses may not pass a station on the right of the bus when a C Train is approaching from the opposite direction.
3. Buses entering 7th Avenue must do so only on a green light. Right turns on red lights are prohibited.

C Train

1. C Trains must not enter an intersection unless the traffic signals are displaying both a walk and a green signal indication.
2. Westbound C Trains may not leave the 7th Street S.W. station until signaled to do so by the switch supervisor.
3. Eastbound C Trains may not leave the 8th Street S.W. station until signaled to do so by the switch supervisor.
4. C Trains shall reduce speed to 30 km/hr (18 mph) when passing under "+15" walkways.
5. C Trains shall reduce speed to 10 km/hr (6 mph) when passing through the 8th Street switch.
6. As with all stations, trains shall sound the bell briefly before moving from a station to alert passengers that the train is proceeding.

Emergency Vehicles

Early in the operation of the C Train, several near-misses between trains and emergency vehicles occurred. A joint meeting between transit, police, and fire department officials resulted in the following rules being drafted.

Fire Department and Ambulance

1. Fire Department and Ambulance Service vehicles will enter 7th Avenue only while on emergency calls.
2. While in motion on 7th Avenue, Fire Department and Ambulance Service vehicles shall have their emergency warning lights and siren in operation at all times.
3. When stopped on 7th Avenue, Fire Department and Ambulance Service vehicles shall, wherever possible, not block the C Train tracks.

City Police

1. City Police vehicles when passing a C Train traveling in the same direction shall activate their warning lights.
2. When stopped on 7th Avenue, City Police vehicles shall, wherever possible, not block the C Train tracks.

General

Emergency vehicles on emergency calls shall, while crossing 7th Avenue, reduce speed so as to allow stopping short of a C Train in motion on 7th Avenue.

Service Vehicles

The following rules were adopted for operation of service vehicles on 7th Avenue:

1. With the exception of Calgary Transit vehicles, entry of service vehicles to 7th Avenue is prohibited except when essential to the completion of the service task.
2. When the nature of the service task requires vehicle access to 7th Avenue, a permit must be obtained 24 hours prior from Calgary Traffic Operations and from Calgary Transit Rail Control. No obstruction of the tracks is permitted.
3. Service work in general must be performed during off-peak hours. Should the nature of the work dictate cutting of power or obstruction of the tracks, such work will be done between 1:00 and 5:00 a.m. or on a Sunday.
4. Costs of replacement bus service shall be borne by the service company.

Control System

The 7th Avenue section of the line is controlled by the standard traffic signals, with the light rail vehicle operating on line-of-sight and governed by all traffic signs and signals. Maximum operating speed for buses and LRVs is 40 km/hr (25 mph).

A special traffic signal governs C Train exit from the tunnel section and provides an additional phase on an existing traffic light controller.

Effect of the C Train on Bus Service

Prior to the commencement of C Train service in the Macleod Trail corridor, transit service was provided by

1. High-speed, limited-stop, high-frequency Blue Arrow Service on three routes. The Blue Arrow Service express bus system was designed to bridge the gap between conventional bus service and LRT. These routes operated on future LRT corridors.
2. Main-line CBD service on one route.
3. DART (Dial-a-Ride Transit) feeder service to the Blue Arrow.
4. Conventional feeder service to the Blue Arrow and the mainline service.
5. Multiple-trip morning and evening Pennant Express. Pennant Express routes picked up passengers in a limited catchment area and proceeded nonstop to the downtown core. A premium fare was charged. Service levels were usually three morning trips (7:00, 7:08, and 7:15 a.m.) from the pick-up area and return trips at 4:00, 4:30, and 5:00 p.m. from the downtown core. The name Pennant Express originated from a colored flag or pennant displayed on the front corner of the bus.

A decision, approved by the City Council, was made that

1. Service that by its nature competed with the C Train would be revised or removed;
2. Feeder service to the C Train would be revised to provide a high level of service to the C Train and a localized crosstown service to activity centers in the area; and
3. Service levels on the C Train would offer a

minimum headway of 15 minutes at all times.

Consequently, a network was devised that consists of feeders to the C Train based on a maximum ride of 20 minutes on the bus. A single main-line bus to the CBD was maintained with routing into the Anderson and Chinook C Train stations. All Blue Arrow and Pennant Express service was deleted. DART service was replaced by fixed-route feeders.

Buses meeting C Trains at stations are scheduled to arrive 3 minutes before the train and depart 3 minutes after, thus allowing 6 minutes for transfers. Connections at stations are staggered to equalize train loading.

A train loading at Anderson station at 7:20 a.m. could theoretically meet 9 buses from 9 feeder routes. If each bus brought 40 passengers, this would take most of the available capacity in the train. Therefore, each train meets 3 feeder routes to equalize train loading. Selection of specific feeder-to-train and feeder-to-feeder combinations is dependent on known volumes on feeder routes and known feeder-to-feeder transfer volumes.

Significant fine tuning of these connection patterns was required during the first 3 months of operation.

When compared with a transfer operation involving several types of bus routes, the train-to-feeder timed transfer has two significant differences:

1. The high dependability of the train arrivals results in a smaller window requirement in the feeder schedule to ensure connections.
2. The difficulty in achieving across-platform bus-to-train transfers results in the need to allow increased transfer times due to significantly longer transfer walking distance.

The first time savings almost exactly offsets the second additional time requirement, so that actual transfer window allowance virtually equals that in a bus-to-bus operation.

Another significant effect on the transfer time is route length. Calgary chose route configurations with round-trip times of about 48 minutes, with 2 station stops of 6 minutes. This fits well with the C Train frequency of 6 minutes peak and 10 minutes off-peak.

From this experience it is evident that the higher the percentage of passengers arriving by feeder bus, the greater the ability to control train loading. Also, in cases of system failure, there is a great predictability of equipment needs to provide short-term solutions.

An introductory free fare week was provided a week before the changes in bus routes took effect. This was designed to ease the initial loading on the C Train.

Public input to the changes was gained by a series of meetings in the affected communities commencing a year before start-up. An ongoing "countdown" campaign kept the public aware of the changes. Approximately a month before start-up, a descriptive brochure was delivered to every house in Calgary. One week before start-up, supervisors in uniform handed out information packages to all affected passengers both on and off the buses.

The results were overwhelming in terms of C Train ridership, from an initial 25 000 per day to the present 45 000 per day. During the 10-day Calgary Stampede, more than 1 000 000 rides were calculated as originating or terminating at the two Stampede stations. When one adds an estimated 36 000 regular rides per day to this, a staggering total of 1 330 000 rides or 133 000 average per day was achieved. This high ridership necessitated some unconventional steps to maintain service:

1. Electro-mechanics rode the trains, curing minor problems and doing door maintenance while in service.
2. Supervisors were stationed at the two Stampede stations to "move" passengers clear of doors and provide crowd control.
3. Portable fareboxes were brought in to supplement overtaxed ticket-vending machines.
4. Buses were used to supplement train service during peak flow. This met with mixed success because many passengers preferred to wait for the train.
5. A mobile on-site command post was used to direct service.

At present the C Train corridor shows a 30 percent increase in ridership, with daily rides in the area of 48 000 per day with a near-capacity 4500 rides in the peak hour on 25 cars in 9 trains (seven 3-car and two 2-car).

Calgary is currently experiencing 100 revenue trips per year per capita and has a goal of 150 trips by the year 2000.

Feeder bus ridership has not reached the desired levels, although park-and-ride lots are overfilled. A campaign using door-to-door leaflets and special bus boards is under way in an attempt to increase feeder bus ridership.

In 1976, 33 percent of all trips entered the CBD by public transit. Now 44 percent of all trips are by public transit. Part of this growth is due to the C Train. There were 109 buses operating on the Macleod Trail corridor. At present there are 82 buses operating in the corridor.

A similar reduction in hours of operation has not occurred, as feeder bus headways have been matched to the train to provide a high level of service and increase ridership.

Actual hours of operation were in fact increased by 72 percent on weekdays, 110 percent on Saturdays, and 52 percent on Sundays. As a result, 75 percent or 30 000 C Train riders reach the C Train by feeder bus.

CONCLUSION

The C Train and feeder bus combination has proved to be a success, as indicated by capacity ridership on the train.

The City of Calgary is proceeding with construction of the northeast and northwest LRT lines as soon as possible. Planning for the southwest and north lines is in the proposal stage.

The existing south line will be extended a further 6 km (3.7 miles) by late 1984.