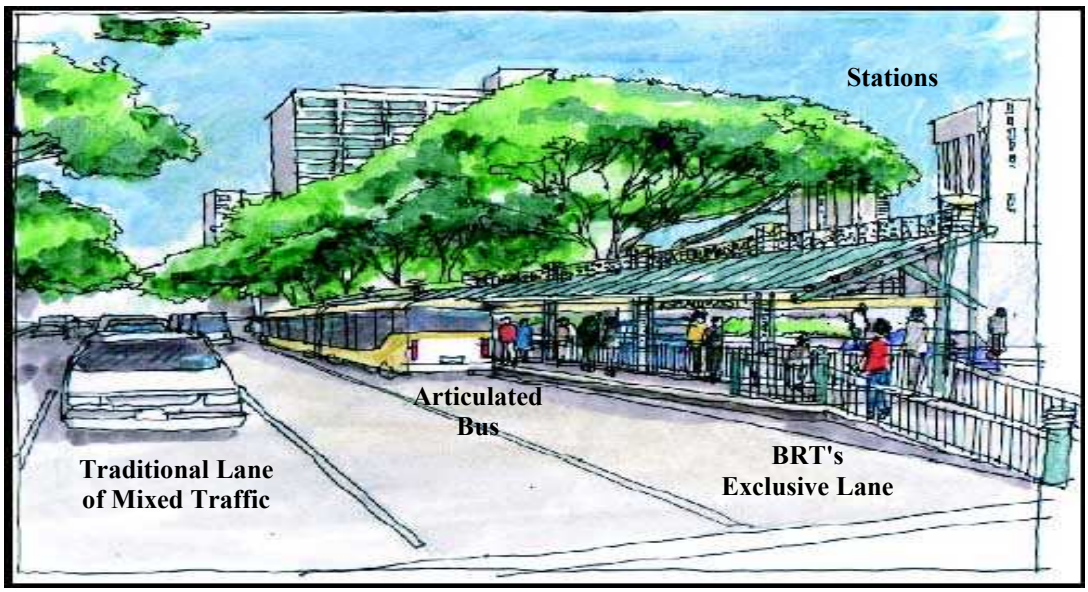
Volume 18, Number 2 ***Special Edition Summer/Fall* 2005**

BUS RAPID TRANSIT (BRT)

Bus Rapid Transit (BRT) are mass transit systems that respond to the need of organizing in an effective manner public transportation of cities in which the systems are applied, and at the same time, offering an alternative for urban development. These systems are structured in exclusive lanes that provide for the operation of articulated buses which can mobilize up to 165 passengers.

To increase the capacity of the system, this main route network integrates to feeder routes, operated by buses which can mobilize up to 40 passengers sitting plus 30 passengers standing. The operation is complemented by a control and monitoring center, which processes information given by the buses and stations allowing real-time adjustments in the operation of the buses.



Conceptual Design of BRT
www.smallbusinesshawaii.com

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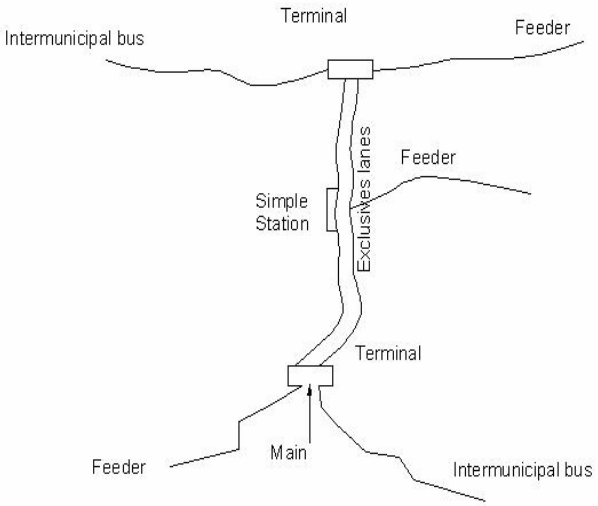
BRT systems are composed of articulated buses that transit in exclusive lanes, with fixed stops that vary from 164 ft apart (50 meters) to 4921 ft (1500 meters), being average stops of 1640 ft (500 meters). These systems address diminishing the cities roadway congestion, by moving an average of 100,000 passengers on a daily basis, with a duration ranging from 24 to 60 minutes.



Analogy of a BRT with a Tree

A BRT system is composed of seven main elements:

1. Articulated buses
2. Exclusive lanes for the main route network
3. Terminals
4. Stations
5. Pedestrian Crossings
6. Feeder routes
7. Maintenance, operation and parking yards

High Platform Articulated Bus

The main route network lanes are the central lanes of the principal avenues of the cities. These lanes are designed to resist the loads associated with the passing of the buses; and are physically separated from mixed-use lanes, which are available for the use of personal vehicles, trucks, taxis, etc.

Stations are the only points along the routes in which passengers are allowed to get on and off the vehicles. These are closed spaces with adequate ventilation build of aluminum, stainless steel and blown glass, with a ticketing center on the entrance and a safe access to users, through the use of pedestrian crossings controlled by traffic lights, and pedestrian bridges or tunnels.

The stations should be equipped with the proper amount of signalization, illumination and furnishings for them to be a safe place for the users, and a place to be comfortable as well. The floor of the buses matches the height of the station platform, allowing a fast and efficient boarding, especially for the elder and disabled users.

Exclusive Lanes and Simple Typical Station of a BRT

Historically, successful BRT systems have three types of stations:

- **Simple Stations –** These stops are typically 1640 ft apart, running on exclusive lanes, where the user can buy the ticket and enter the BRT system.

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In This Edition…

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- **Terminals –** Starting and finishing point of a main route. This type of station serves the purpose of transferring between feeder routes, main route networks and intermunicipal transit systems.

Terminal

- **Intermediate Stations** – These are intersections in strategic points where the users are allowed to make transfers. The fare is not charged twice.

Intermediate Station

Continued on Page 4...

- **Pedestrian Crossings** - BRT systems should focus on providing the pedestrians with safer and more comfortable mobilization. The elements taken into account are bridges, tunnels, leveled pedestrian crossings controlled by traffic lights, adequate signaling, walkways, etc.

Access to a Pedestrian Bridge

Pedestrian Bridge

- **Parking, Operation and Maintenance Yards** - These facilities provide for the maintenance activities of the buses as well as the storing of the buses once the service is completed for the day.

Maintenance Yard

- **Feeder Routes** - In the main network, the service is offered by the articulated, higher capacity buses. These buses are not feasible for use in the areas adjacent to the main routes. This is because of the demand in these areas. The peripheral areas of the cities have a low demand, hence medium and low capacity buses are used for these zones, since they will fit better the capacity panorama of these areas. This allows the user to reach a main network without having to pay a double fare.

Feeder Bus

Continued on Page 5...

The main advantages of the BRT system are:

1. Saving travel time trough higher speed travels
2. Savings in operational costs due to higher efficiency in operation and maintenance
3. Generating job for the automobile industry, direct and non-direct temporary jobs in infrastructure, and permanent jobs in the operation of the system
4. The construction costs for a BRT are much lower than those for a subway line, due to infrastructure necessary for the system's operation
5. It is a more flexible system than a subway system, due to the easiness of repairing main routes and while still operating

The first generation of BRT systems were implemented at several cities through South America and USA. Six of the major cities include: Curitiba (Brazil), Porto Alegre (Brazil), Bogotá (Colombia), Chicago (USA), Santiago (Chile) and Quito (Ecuador).

In order to understand better this system, the following terms are defined:

BRT: Bus Rapid Transit. Exclusive lanes in traffic for bus rides, and stops along the same lanes.

High Capacity Bus: Buses with 165 passengers capacity riding on exclusive lanes; the amount of passengers is determined by the average weight capacity of the buses. If the bus exceeds this weight it will not ride.

Low Capacity Bus: These buses are used to feed the BRT system, and they usually move 40 to 70 passengers.

Headway: It is the time between two bus rides, varying between 1.5 to 60 minutes.

Height Platform: It is the height measured from the ground to the floor of the bus. This value is usually of 90 cm (3 ft).

Main Lanes: Exclusive lanes for the BRT buses.

Test your knowledge answering the following statements about BRT systems:
True (T) or False (F)

Statement	**T/F**
1. BRT systems work on rail lanes	
2. You can purchase the tickets for the system at any station	
3. The main stops of the BRT are located approximately every 500 m (1640 ft) on the lanes of the system	
4. San Juan, Puerto Rico recently inaugurated a BRT system	
5. The buses of the BRT system are articulated	

The solution of this test is on page 13.

BRT's IMPLANTATION FOR THE MUNICIPALITIES OF PUERTO RICO

Puerto Rico has a total of 14,704 mi (23,665 km) of roadways (including 264 Mi (426 km) of expressways).

Map of Puerto Rico

The high dependence Puerto Ricans and other residents of the island on private vehicles, the increase in the number of drivers per year (40 vehicles for every 1000 habitants and 2.8 million vehicles approximately, in a population of 4 million habitants) and the low quality of the services provided by public transportation, which in some municipalities is non-existent, makes traffic congestion increase every day, reducing speed of the vehicles and increasing travel time.

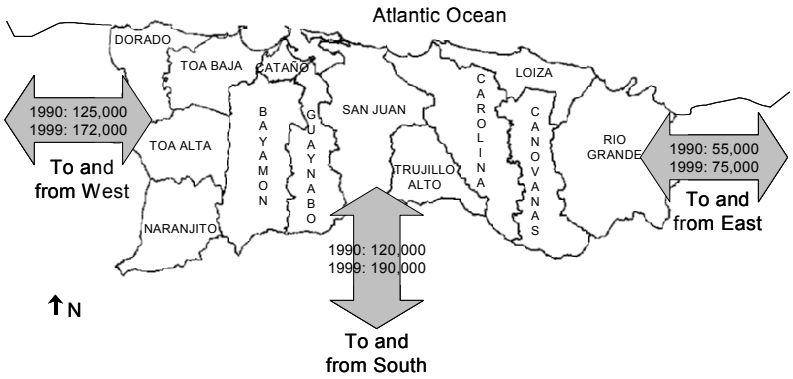
Because of this, it is necessary to take action to reduce traffic congestion and diminish the use of private vehicles by offering a service of mass public transport that is efficient, economic, comfortable, and clean for the users.

One of the solutions that is proposed for the different municipalities of Puerto Rico, including the metropolitan area of San Juan, is the implementation of a system of public transport such as the BRT (Bus Rapid Transit).

In order for a municipality to implement a BRT system the following eight (8) factors must be considered:

1. Willingness of the Mayor to implant it and to include it in his list of priorities in his governing plan.
2. Speed of operation.
3. Reduction of travel time.
4. Reduction of waiting time.
5. Low costs in the operation and maintenance of the system and the traffic fleet.
6. Origin and destination of the users of the system.
7. Suitable planning of the routes of the system.
8. Planning and integration with other means of transport.

As can be seen, in the figure to the right, the main movement of vehicles towards the metropolitan area is found in Caguas, which is located to the south of this area. The second area, which has a large movement of vehicles, is towards the west side of the Island, which increases congestion. Both in the year1990 and in the year 1999 this trend remained in these two areas.



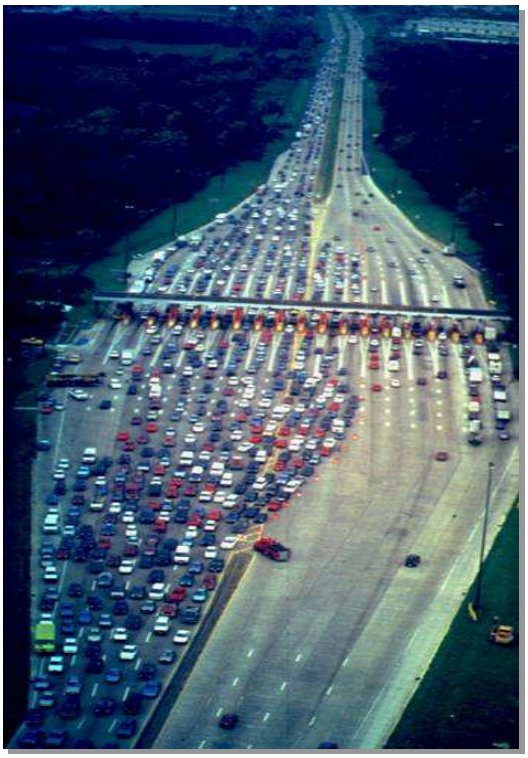
Vehicles Per Day in Both Directions During the Years 1990 and 1999
Source: Metropolitan Plan of Transportation San Juan 2025, 2000

Continued on Page 7...

In the Caguas municipality case, a solution proposed to diminish the high traffic flow on highway PR 52, is the implementation of a BRT system. The route will go from a terminal in Caguas to the Tren Urbano stations located in Centro Médico or Cupey. By doing this, there's no need to buy another ticket to transfer from the BRT to the Tren Urbano.

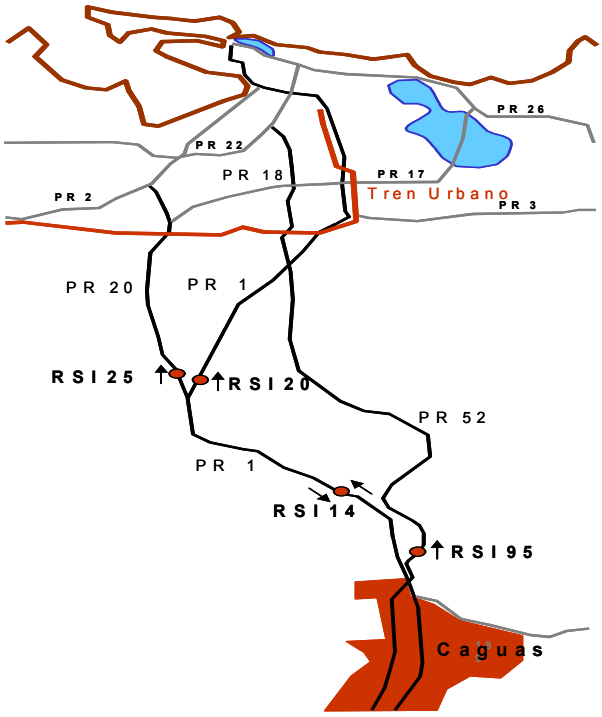
The different means of transportation must be integrated into a BRT system. For the case of the metropolitan area of San Juan, the public cars and the buses of AMA, can be integrated as services of feeders routes to the BRT system and to the Tren Urbano, satisfying the demand around the metropolitan area.

The implementation and construction of a BRT system can be extended to other zones of the metropolitan area, such as Carolina, avoiding the construction of extensions of the Tren Urbano and diminishing significantly the costs of construction, operation, and maintenance of the system. This type of system can be implemented on a smaller scale, in other municipalities.



Congestion in the Morning at the Entry of San Juan

According to Dr. Sergio Gonzalez, Ex-Secretary of Transportation and Public Works, a BRT limits itself to lanes of significant length, with a relatively high flow of collective transportation (in the context of Puerto Rico more than 10,000 passengers a day and preferably 20,000 passengers per day) and that have significant congestion.



Tracing of the Route of the Caguas BRT - San Juan
Source: Pilar Rodríguez MIT

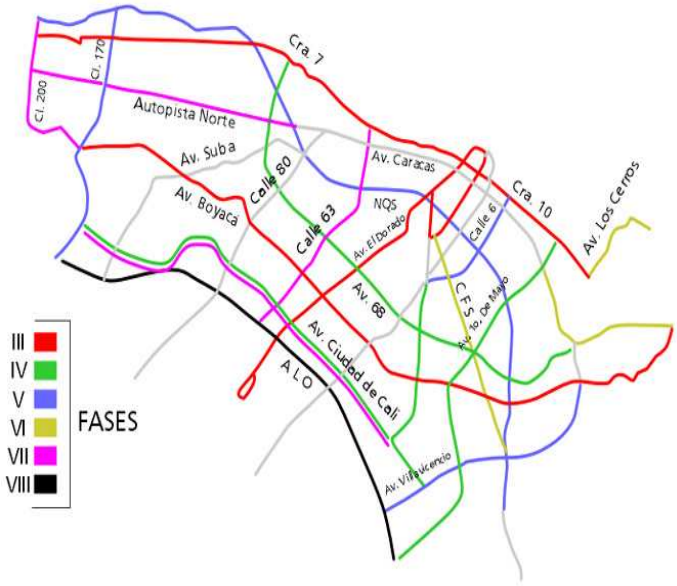
Outside the metropolitan area the implementation of these systems can be evaluated in municipalities like Mayagüez and Ponce . On the other hand, for the extensions of the Tren Urbano to Carolina and Caguas the BRT should be evaluated. In the same way, it would make sense to evaluate the BRT to extend the Tren Urbano to Carolina up to Canóvanas and Bayamón up to Dorado. (Here the traffic flows are bigger than 90,000 per day) At the extremities of Tren Urbano, parking and connections with other means of transportation would need to be added.

Viability studies must be considered for the construction of the above mentioned systems, so as not to incur unnecessary expenses and excessive works that ultimately, are underused and to avoid the squandering of the money of the contributors.

A SUCCESSFUL BRT CASE: TRANSMILENIO, BOGOTÁ (COLOMBIA)

Transmilenio is a mass transportation system which responds to the need of organizing public transportation in the city of Bogotá, and, at the same time offers an integral alternative to the urban development. This system is administrated by Transmilenio S.A.

The buses, including the system feeders, are property of private companies which give the service by a concession system.



Global Project of Transmilenio S.A.

The fee collection is also done by a private entity. The earnings obtained from the tickets are designated to the payment of services to the transporter companies. This is used in turn to pay the cost of the trips by kilometer, station maintenance and operational expenses of the Transmilenio S.A. control center, a company whose stockholders are public entities from the Capital District.

The Urban Development Institute (UDI) in charge of building and administrating the vial system of the transport and public space, builds the infrastructure of the system.

The Transmilenio system components include exclusive roads for the Transmilenio buses, mixed lanes, feeder routes, stations, walker bridges, yards and portals. Footwalks, avenues and public squares are part of the system and their expenses are included in the total cost of the road.

Trunk (Troncales)

The Transmilenio system operates under a trunk scheme feeder. For this effects there are principal paths (trunk) with lanes which are mostly designated exclusively to the operation of the PMTS (Public Mass Transport System), in which circulates confined vehicles of high capacity mass transportation. This network of principal lines is complement by secondary routes (feeders) operated with minor capacity buses.

The infrastructure which integrates the system in its different elements and components, is explained in detail in the next topic.

Trunk Lines (Líneas Troncales)

The distribution of the streets in Bogotá is like a grid; the streets increase its nomenclature from south to north and the "Carreras" from east to west. The first level of the project involves the positioning and set going of seven trunk corridors above the principal roads of the city. This first level is divided in two phases. The first phase of the project, included a main street, a highway and a "Carrera", the second phase includes the integration of these corridors to 3 streets that crosses the city and two "Carreras".

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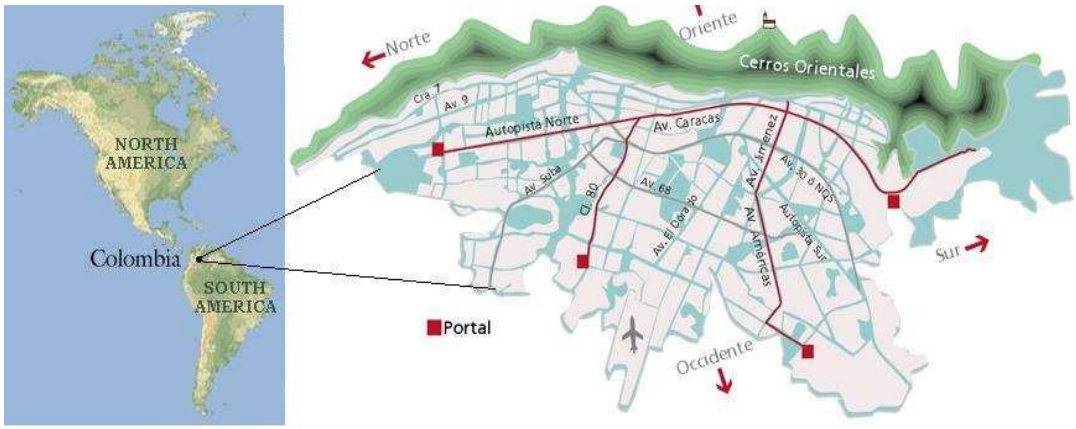

Map of Bogotá with the Actual Routes of Transmilenio
Source: www.transmilenio.gov.co

System Station with Articulated Buses

The infrastructure of Transmilenio is composed of a bus operating system, collection equipments and management supported by the control center. The District is responsible for the construction and maintenance of the infrastructure and the supplying and operation of the equipment of the control center. By its part, the private sector supply and operate, by concession contracts, the busses and the collection equipment. The incomes of the activity should cover all the operational expenses, maintenance, equipment restorations and all the utilities of the private actors in the system. Through a commercial fiducial, the private sector receives the collected money and it is distributed between the system agents according to the contractual rules established on the bidding processes.

The infrastructure of the Transmilenio system utilizes the central lanes of the principal roads of the cities. These lanes are conditioned for the circulation of the buses articulated and they are physically separated of the mixed lanes, which are available for the circulation of particular vehicles, taxis and trucks. The infrastructure also includes the positioning of roads and stops for the feeders routes, stations in which the trunk runners with walk access facilities, maintenance for the yards and parking of the buses an the control center.

The estimated cost of the Transmilenio infrastructure goes up to $1,970 US million and the contemplated plan by the District comprehend the construction, during 16 years, of 388 km (241 mi) of trunks, until it covers the 80% of the public transportation of the city. During the same period, 4,475 articulated buses are expected to operate.

Feeder Buses of the Transmilenio System

Continued on Page 10...

The total cost of the buses is approximately $900 US million. The technology used guaranties the fee collecting under different manners of prepaid and it allows the fees integration with the feeder busses. The cost of the equipments for collection is estimated on $74 US million.

The actions regarding the operation, development and execution of the Transmilenio system are distributed between the District organisms through auctions according to the local regulation in compliance with national legislation. The institutional coordination for the service offered of the urban public transportation of passengers is a function of the Transit and Transport Secretary, Unique Authority of the District Transport. As such, it is the manager of planning, controlling and monitoring the public transport of the city, obeying unified criteria of town planning, public works, traffic and transport.

The five (5) agents of the Transmilenio system are:

1. Planning, Control and Management
2. Trunks Operators
3. Operators of the Feeders Services
4. Operator of the Collection
5. Manager of the Resources of the System

Purchase of tickets (intelligent and similar cards) on stations using: automatic machines, nourishing buses, among others.

The management, planning, regulation and control of the System of Passenger's Public Mass Urban Transport correspond to the Company of Transport of the Third Millennium TRANSMILENIO S.A. On its part, the Institute of Urban Development - IDU is the person in charge for the construction, maintenance and improvement of the infrastructure of the Transmilenio system.

The experience of the Transmilenio system is an offer to improve the urban mobility in Bogotá by means of a system of transport of great importance that is served by buses of high occupation. The principal objectives of the Transmilenio system are to improve the quality of life of the citizens and the productivity of the city. Essentially, Transmilenio is ruled based upon the six fundamental principles listed below:

A. The respect for life
B. The time of citizens
C. The human diversity
D. The quality
E. The coherence
F. The capacity

Since its implementation and operation important achievements have been obtained. They have diminished the indexes of duration of the trips, as well as those of pollution for gas and traffic accidents. More than 1,500 obsolete vehicles have been retired. The exclusive lanes used for vehicles of high occupation are safer.

The citizens, users and non-users have changed their attitude. The procedures of citizenship are fulfilled and respect. The above mentioned procedures foment the solidarity, the respect and the commitment. The children have taken specially conscience of the system, seeing its beginning and development.

NUMBERS UNTIL MAY 2005		
Attributes	**Value**	**Units**
Ridership	926,285,570	Passengers
Average of passengers x operation hour	103,616	Passengers
Total feeder	428,948,591	Passengers
Total Intermunicipal	58,197,575	Passengers
Stations in Operation	78	Stations
Kilometers of Route in Main Operation	55	km
Bus Fleet	627	Buses
Average Speed until January, 2005	26,06	km/hour
Crossed Kilometers until May 01, 2005	173,809,322	km
Feeders Routes	54	Routes
Available Feeder System	362	Buses
Feeders Neighborhood (aprox.)	78	Neighborhoods
Total Feeder Operation (aprox.)	421	km

Source: Transmilenio S.A. www.transmilenio.gov.co

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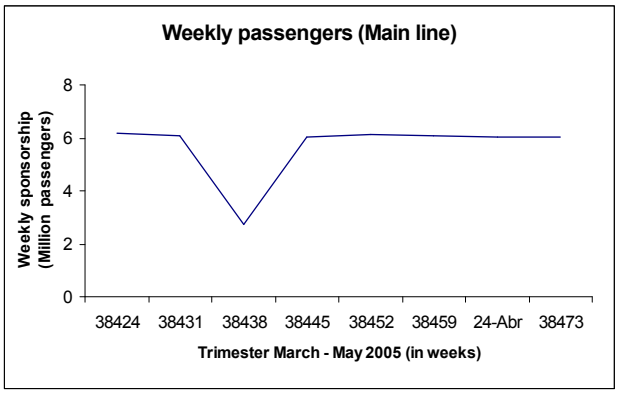
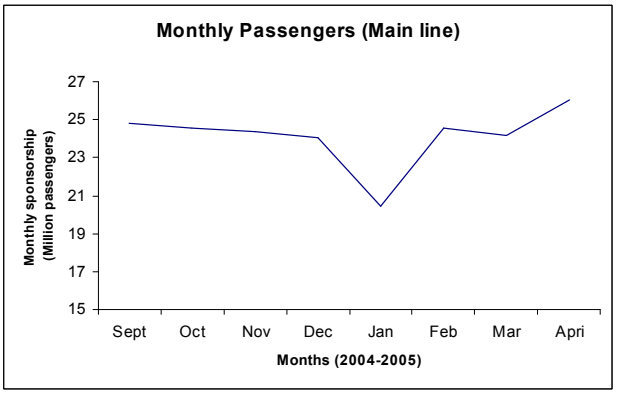
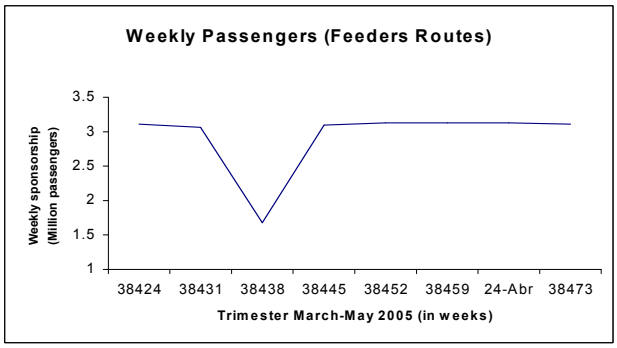
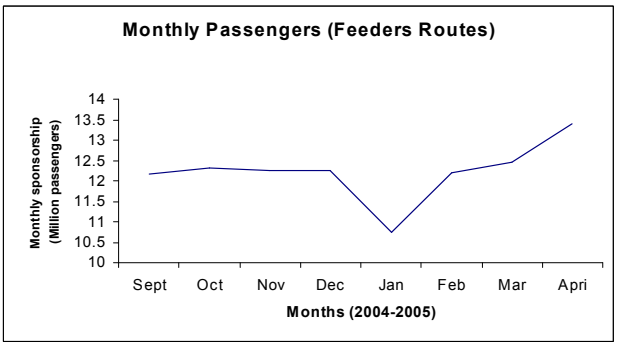
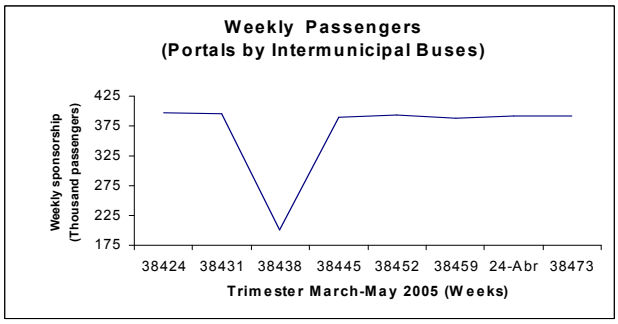
BRT's BEHAVIOR EVALUATION MEASUREMENTS

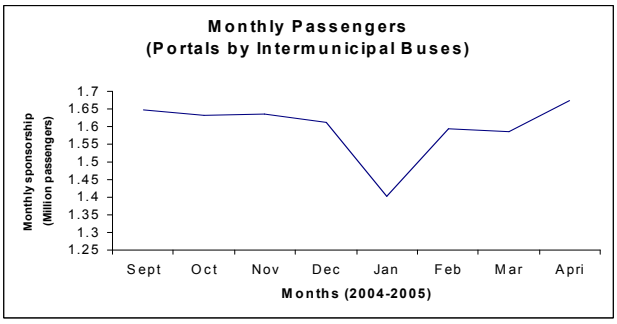












In the previous graphs it can be observed the passenger's volume mobilized weekly and monthly by the different elements of the Transmilenio system: articulated buses in the trunks, feeder and intermunicipal buses.

It is necessary to point out that in the Holy Week of 2005 the sponsorship of the BTR diminished dramatically, this is because there are no classes, both in schools and universities, and some companies give the week free to their personnel.

January presents the major decrease of the sponsorship due to the summer vacations taken by the people of Bogotá and consequently, they travel out of the city.

SERVICES				
TYPE	**HEADWAY (AVERAGE)**	**SCHEDULE**		
	(in minutes)	**OPEN**	**CLOSE**	**DAYS**
CURRENT	3	5:00 AM	11:00 PM	Monday to Sunday
EXPRESS	2 to 3	5:30 AM	11:00 PM	Monday to Friday
EXPRESS	2 to 3	6:00 AM	10:00 PM	Saturday
SUNDAY	3	6:00 AM	10:00 PM	Sunday
SUNDAY EXPRESS	3 to 4	8:00 AM	9:00 PM	Sunday
FEEDERS	5	4:35 AM	11:45 PM	Monday to Sunday

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Actualización de Nuestro Directorio

Ayúdanos a actualizar el directorio del Centro de Transferencia de Tecnología en Transportación completando esta hoja de información y enviándola por facsímil al numero (787) 265-5695. Muchas gracias.

☐ AÑADIR ☐ REMOVER ☐ CAMBIAR

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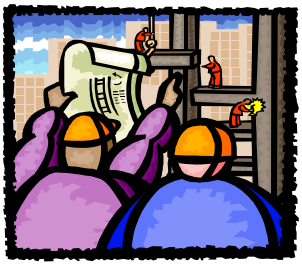
FUTURE EVENTS



August 20-23, 2005
SASHTO 2005 64th Annual Meeting
Wyndham El Conquistador Hotel
Fajardo, Puerto Rico
Web-Page: www.sashto.org

September 11-14, 2005
2005 APWA International Public Works Congress and Exposition
Minneapolis Convention Center,
Minneapolis, Minnesota
Web-Page: www.apwa.net

September 13-16, 2005
2005 ARTBA Annual Convention
Breakers Resort
Palm Beach, Florida
Web-Page: www.artba.org

September 16-19, 2005
AASHTO Annual Meeting
Opryland Hotel
Nashville, Tennesse
Web-Page: www.tdot.state.tn.us/aashto

November 27-30, 2005
XIX ALAMYS Annual Meeting
Medellín Colombia
Web-Page: www.alamys.org

July 30 - August 3, 2006
Second International Transportation Technology Transfer Symposium
St. Petersburg, Florida
Web-Page: www.t2symposium.org

Solution for the test on page five:

1. **False**. BRT systems works on exclusive lanes without rail.
2. **True**.
3. **False**. The typical or average stops are located approximately every 500m (1640 ft).
4. **False**. "Tren Urbano" was inaugurated in December 2004 and fare collection started in June 6, 2005.
5. **True**.

The Center's staff welcomes your questions and suggestions. To contact the Center, please send all correspondence to the following address:

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