What is BRT?

Sam Zimmerman
BRT: Bus Rapid Transit

- **Flexible**, permanently integrated, high performance system with a quality image and a strong ID

- Package of components appropriate to current and future:
  - *Markets served*
  - *Physical, operating environment*
BRT System Elements

- **Vehicles**
- **Running Ways**
- **Stations & Terminals**
- **Systems**
- **Service Plan**
# Flexibility of BRT

<table>
<thead>
<tr>
<th>Simplest</th>
<th>Stations</th>
<th>Running Ways</th>
<th>Service Plan</th>
<th>Vehicles</th>
<th>Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g., Rapid Bus</td>
<td>“Super” Stops, Shelter</td>
<td>Mixed Traffic, Queue Jumpers</td>
<td>Trunk/ Feeder: Single All-Stops Trunk Line</td>
<td>Buses with Unique Rte. ID’s, Head Signs</td>
<td>Digital Radios, Electronic Fare Boxes</td>
</tr>
<tr>
<td>BRT “Lite”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest Capacity,</td>
<td>High Platforms, P/R,</td>
<td>Fully Grade-Separated Transitway</td>
<td>Combo.: All-Stops; On-Line Expresses; Integrated Feeder/ Trunk</td>
<td>Hybrid, Guided Specialized Vehicles</td>
<td>Central Control Room, TSP, CAD, Off-Board Fare Collection, Smart Cards</td>
</tr>
<tr>
<td>Performance</td>
<td>Amenities, Services</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.g., Transmilenio</td>
<td></td>
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</tr>
</tbody>
</table>
BRT
Infinite Possibilities, But …

Must have essential attributes

• **Integrated system** to ensure **high speed, reliability**

• **Easy to use:**
  – **High service levels** at all times
  – **Simple network structure**
  – Identity, image, “branding”

• **Attractive:** **High** over-all quality

*Without these attributes, “BRT is only old wine in a new bottle”*
Running Ways

• BRT can operate in broad variety of physical and operating environments, but as much segregated, dedicated running way as possible

• Critical planning and design criteria:
  – Safe, rapid, reliable service
  – Safe BRT vehicle access
  – Efficient traffic operations
  – Good community integration
  – Easy enforcement of dedication
Arterial Curb Bus Lanes

Hangzhou, China

London
“BRT Lite”
Arterial Median Transitways

Nagoya

Mexico City

Jinan

Paris
One-Way Streets

Guayaquil

Pereira
Bus/Transitway on Expressway/Freeway ROW’s

Median
Beijing

Shoulder
Brisbane: SE Busway

Median
Istanbul
Busway on Railroad ROW

Amsterdam: Zuidtangent

Pittsburgh: East (MLK) Busway
Passenger Information

Beijing

At Stations

Jinan

On Board
Stops, Stations and Terminals

• .5 – 2 Km. station spacing
• Permanent, substantial, weather protected
• Amenities, passenger information
• Safe pedestrian, bike access
• Seamless local bus, auto access
• Safe, secure
• Convey identity and image
• Design integrated with surroundings
Low Volume Stations

Eugene EMX

Amsterdam

LA Orange Line

Brisbane
High Volume, Capacity Stations

Brisbane

Bogota
Transmilenio

Mexico City
Intermodal/Interchange Terminals

Guayaquil

Leon, Mexico

Bogota
Vehicles

• Rubber-tired, steered and/or guided
• Variety of sizes through 27 Mtrs.
• Conventional buses or specialized BRT
• Environmentally friendly
  – Low air pollution emissions
  – Quiet
Conventional Buses

Marco Polo/Volvo High Floor
18 Mtrs
Mexico City

18 Mtrs, Low Floor
Jinan
Specialized BRT Vehicles

Evo/Mercedes
“Capacity”
19.5 Mtrs
Istanbul

Buscar/Volvo

27 Mtrs
High Floor
Bogota
BRT Vehicle Interiors
Open, Well-Lit, Attractive

Marco Polo, etc./Volvo
• Leon, Mexico
• Mexico City
• Bogota

NABI
Metroliner
LA
Vehicle/Station Interface: Level, No Gap Boarding, Alighting
Vehicle Guidance

Optical
- Rouen, France

Mechanical
- Adelaide
- Cleveland
- Leeds
- Cambridge

Magnetic
- Eindhoven, Ndl.
Fare Collection

- Needs to facilitate fast, efficient multiple stream boarding
  - Off-board (preferred)
  - On-board multi-point payment
  - Significant pass utilization

- Integrated with but may not be the same as for local bus system

- “Smart (IC) Cards” rapidly finding favor as fare medium of choice
  - Fare gates
  - Barrier-free
Off–Board Fare Collection Options

Smart Card Fare Gates
TransMillenio, Bogota

Smart Card Fare Gates
Megabus, Pereira
BRT ITS Applications

- Automatic vehicle location
- Service dispatching, monitoring, supervision
- Passenger information
- Safety, security
- Signal priority
- Communications
- Fare collection
- Vehicle guidance and control
Central Control Room
Service Monitoring, Supervision

LA Metrobus
Service Supervision: Beijing
Station Security: CCTV
Passenger Information: Beijing BRT

At Stations

On Board
BRT Service Plan Basics

• All-day, week frequent service
  – Max. interval 5-10 minutes in peaks
  – Max. interval 10 minutes in off-peak

• Simple network structure
  – Minimum variations
  – Less than 4 distinct BRT routes/station preferred

• Easy to understand
Service Plan. Development Objectives

• Service plan based on market, physical and operating environment
  – O/D patterns, volumes
  – General traffic patterns, volumes, especially at intersections
  – Road space
  – Adjacent land uses
• Maximize speed, minimize indirectness of travel, transferring
Service Plans

• Integrated with rest of transit network: Not just trunk route(s)

• Two basic options:
  1. Trunk/Feeder
  2. Integrated
“Trunk” Alternatives

• Single, all-stops line

• Multiple trunk lines
  – Local
  – Limited stop
  – Express
BRT Service Plan Options: Single All-stops Route/Corridor

All-day, all-(limited) stops trunk line

(e.g., Mexico City, Beijing, Quito, LA, Jakarta, Istanbul, Curritiba)
All Stops Local + Multiple Expresses

- **Base:** All-day, all-stops trunk line
- **Overlay:** Peak-only or all-day express services

Diagram showing stations and transfers with labels for local, super express, and express services. Stations are marked with circles, and transfers are indicated. The diagram includes labels for specific locations such as University, Hospital District, and (e.g., Bogota).
Integrated (e.g. Ottawa, Brisbane)

- Base: all-day, all-stops trunk line
- Peak-only or all-day integrated services
- Peak-only or all-day expresses
“Open” Service Plan

Transitway Portion of Route
Off-Transitway, Mixed Traffic Portion of Route

Extended/Express BRT Route II
Extended/Express BRT Route III

End of Transitway Terminal

Station Station Station Station

Local

Express/Route II Express/Route III

Local

C B D

e.g., Dar es Salaam, Accra
Conveying Brand Identity, Image: Pervasive and Consistent

• Vehicles:
  • Design, colors, graphics, signage

• Stops, Stations, Terminals:
  • Design, colors, graphics, signage, materials

• Running Ways:
  • Barriers, pavement markings/materials/ colors, graphics, signage, landscaping
Consistent, Unique Station Design

LACMTA

Local Bus: Not

MetroRapidBus BRT “Lite”

Orange Line BRT
Functional Hierarchy
LA Vehicles

Local Bus

Metro Rapid
BRT “Lite”

BRT
Orange Line
Running Way Color, Markings

Paris

Nagoya

Wellington
Consistent, Unique Graphics, Icons

Brisbane: S.E. Busway

South Bank

Woolloongabba
BRT Experience To Date
## Total Daily BRT Ridership

<table>
<thead>
<tr>
<th>System</th>
<th>Trips/Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing South Line</td>
<td>&gt;120,000</td>
</tr>
<tr>
<td>Mexico City MetroBus</td>
<td>&gt;300,000</td>
</tr>
<tr>
<td>Leon, Mex. “Oruga”</td>
<td>225,000</td>
</tr>
<tr>
<td>Transmilenio System</td>
<td>~1.4 million</td>
</tr>
<tr>
<td>Istanbul</td>
<td>&gt;600,000</td>
</tr>
<tr>
<td>Brisbane SE Busway</td>
<td>&gt;80,000</td>
</tr>
<tr>
<td>Ottawa Transitway System</td>
<td>200,000</td>
</tr>
</tbody>
</table>
## Attractive to New Customers

<table>
<thead>
<tr>
<th>New Transit Trips</th>
<th>% of Initial Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmedabad</td>
<td>&gt;50%</td>
</tr>
<tr>
<td>Mexico City</td>
<td>&gt;15%</td>
</tr>
<tr>
<td>Jakarta</td>
<td>&gt;15%</td>
</tr>
<tr>
<td>Bogota</td>
<td>&gt;20%</td>
</tr>
</tbody>
</table>
# Mexico City Insurgentes:
**Prior Modes: Corridor, 6.2006**

<table>
<thead>
<tr>
<th>Prior Mode</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto</td>
<td>9.6%</td>
</tr>
<tr>
<td>Taxi</td>
<td>5.9%</td>
</tr>
<tr>
<td>Collectivo (Mini-Bus)</td>
<td>76.5%</td>
</tr>
<tr>
<td>Metro</td>
<td>7.3</td>
</tr>
<tr>
<td>Other</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

*“Transport and Climate: Lessons from the Partnership between Mexico City and the World Bank,” 5/2207*
## Resulted in Significant Increases in Revenue Speeds over Local Bus

<table>
<thead>
<tr>
<th>BRT Line/System</th>
<th>% Speed Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico City</td>
<td>100%</td>
</tr>
<tr>
<td>Bogota (all corridors)</td>
<td>35%+ (est.)</td>
</tr>
<tr>
<td>New York “Select Bus” BRT “Lite”</td>
<td>20-25% (compared to former limited route)</td>
</tr>
<tr>
<td>Beijing</td>
<td>35%+ (est.)</td>
</tr>
<tr>
<td>Seoul</td>
<td>32-85%</td>
</tr>
<tr>
<td>Istanbul</td>
<td>350%</td>
</tr>
</tbody>
</table>
Capacity: Rarely an Issue

• High volumes (e.g., Transmilenio, >35,000/Hr., Istanbul > 19,000/Hr.) can be carried at reasonable levels of service and comfort

• Capacity covers range of LRT and much of Metro experience
  – Metro: 4,000 - 75,000/Hr.
  – LRT: 1,500 – 15,000/Hr.
## Actual Maximum Load Point
### Peak Hour, Pk Direction Volumes

<table>
<thead>
<tr>
<th>Location</th>
<th>Volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bogotá Transmilenio, (passing lanes all stations)</td>
<td>&gt;35,000/Hr.</td>
</tr>
<tr>
<td>Porto Alegre, Sao Paulo, Istanbul, Brisbane, Istanbul</td>
<td>15 – 25,000/Hr.</td>
</tr>
<tr>
<td>Curitiba, Ottawa, Quito</td>
<td>10 – 15,000/Hr.</td>
</tr>
<tr>
<td>Mexico City, Leon, Mex. Quito, Beijing</td>
<td>3 - 10,000/Hr.</td>
</tr>
</tbody>
</table>
BRT - Limits of capacity

Commercial speed (km/h)

<table>
<thead>
<tr>
<th>Capacity (ppdph)</th>
<th>100 p/bus</th>
<th>160 p/bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 lane everywhere:</td>
<td>150 buspdph</td>
<td>15000 ppdph</td>
</tr>
<tr>
<td>2 lanes in station:</td>
<td>300 buspdph</td>
<td>30000 ppdph</td>
</tr>
<tr>
<td>2 lanes everywhere:</td>
<td>300 buspdph</td>
<td>30000 ppdph</td>
</tr>
</tbody>
</table>

~2 km/h

*Source: Montassar DRAIEF - SYSTRA
BRT Maximum Load Point, Peak Hour, Peak Direction Volumes*

*From presentation by Dario Hidalgo, WRI/EMBARQ
North American LRT Demand
Peak Hr, Pk. Direction, Max. Load Point

*Transportation Research Board*
“Transit Capacity and Quality of Service Manual”
Implementation Costs: Generally Modest

• A function of:
  – Implementation environment
    • Physical, operations conditions
      – Available ROW
    • Market
  – Nature of system
    • Vertical, horizontal alignment
    • Design details
    • Required capacity
# Implementation Costs

<table>
<thead>
<tr>
<th>City - System</th>
<th>Total Costs ($M/Km.)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico City</td>
<td>4</td>
</tr>
<tr>
<td>Leon, Mexico</td>
<td>2</td>
</tr>
<tr>
<td>Beijing</td>
<td>5</td>
</tr>
<tr>
<td>Pereira, Columbia</td>
<td>4</td>
</tr>
<tr>
<td>Transmilenio, Istanbul</td>
<td>8-15</td>
</tr>
</tbody>
</table>

* unit costs include all BRT elements
Operating and Maintenance Costs

• BRT O/M Unit Costs a function of:
  – Required Capacity
  – Level of sophistication and system content
  – Operating speeds
  – Service patterns and peaking characteristics
  – Unit labor and other costs
Operating and Maintenance Costs

- BRT O/M $/passenger trip and /Km. will be different than average for local bus system
  - Significantly higher revenue speeds
  - Higher passenger productivity/Hr., /Km.
  - Significantly different service peaking, span
  - Larger vehicles
  - More support “systems”
  - More infrastructure
Operating and Maintenance Costs

• Generally modest

• Comparisons to rail rapid transit depend on trade-off among
  – direct operating costs (i.e., drivers)
  – additional mechanics, technicians required for rail rapid systems
Operation costs including depreciation ($/seat.km)

Source: Montassar DRAIEF - SYSTRA
Attractive to Developers, Owners

• Significant Urban Development Effects
  – Curitiba
  – Bogotá
  – Jinan
  – Brisbane SE Busway
  – Ottawa Transitway System
  – Boston
Transit-Oriented Land Use, Curitiba

Shopping

High Density Mixed
Amarillo Developers
Bogota
Bogotá Transmilenio

Malls

Mixed-Use Development

First New Office Tower In CBD in Decade
Bogotá Transmilenio
Residential
Incremental Annual Property Value Increase, Places in Walking Distance to Transmilenio Station Versus Control*

* “Land Lines,” Lincoln Institute of Land Policy, April 2008 issue
Jinan, China
Brisbane SE Busway
Brisbane SE Busway
Busway boosts house values

Joel Butrey

PROPERTY values along Brisbane's South-East Busway have jumped as much as 20 per cent as buyers take advantage of upticks being driven by the city.

Prices in the southern suburbs of Holland Park West, Upper Mount Gravatt and Eight Mile Plains have increased since the $650 million busway opened in March, providing an escape from South East Freeway traffic snarls.

Real Estate Institute of Queensland research shows suburbs with direct access to the busway's stations had solid growth over the recent quarter.

"Most other suburbs next door to those busway suburbs are performing well, however they did not record percentage changes slightly below those near the busway," REIQ president Mark Erbimble said.

The most outstanding jump was in Holland Park West, where values rose 20.38 per cent.

The neighbouring suburb of Holland Park, which does not have direct busway access, rose 0.23 per cent.

The comparisons showed busway suburbs were performing above city-wide increases which have seen nearly all areas within 10km of the CBD improve in value.

Other neighbouring suburbs that did not perform as well include Mount Gravatt East, which recorded 4.76 per cent compared with 0.23 per cent in the busway suburb of Mount Gravatt, and Mansfield, which increased by 1.66 per cent compared with a jump of 3.90 per cent in busway suburb Eight Mile Plains.

"This research supports the trend that more people are moving to areas within five to 10km of the CBD which are close to convenient public transport such as the busway," Mr Erbimble said.

Queensland Transport recorded a "parking boom" on the busway with a 40 per cent growth in passenger figures in the first six months, or about 46,000 passenger trips a day.

The figures also showed approximately 375,000 private vehicle trips were converted to public transport along the busway, which straddles the South East Freeway.

Property values also would increase if proposed extensions of the busway along northern and eastern routes went ahead, analysts said.

National Property Research analyst Matthew Gross said areas near public transport nodes would usually always rise in value.

"Historically, housing has always followed public transport routes. Those closer to transport generally have higher values," Mr Gross said.

"A lot of investor stock and rental properties are considered worth more if they are close to public transport because they are easier to rent."

The $135 million Inner Northern Busway is nearing completion, and the planned dedicated bus lanes will get passengers to and from Kedron.
Lessons Learned

Wright Group UK
“Streetcar”
Lessons Learned

• BRT is an attractive, potentially cost-effective rapid transit option
  – High speed, reliable service relative to local bus,
  – Attractive to passengers of all incomes
  – Attractive to developers
  – Relatively modest costs, easy to build and operate

• BRT can be a valuable addition to the public transport network of almost any city, including those with existing Metros and/or LRT or cities planning them
Advantages of BRT

• Flexibility and adaptability
  – Ability to serve variety of travel/land use patterns
  – Can work even if <100% ROW dedication
  – Can easily upgrade vehicles, systems
  – Sufficient capacity for most corridors

• Speed of implementation
  – Simplicity
  – Local experience with bus-based systems and highways
  – Procurement of vehicles and systems
Advantages of BRT

• Already significant amount of road space taken by public transport in cities needing rapid transit
• Lends itself to competitive contracting with current public transport operators
• Modest cost, leaving $ for more system, NMT, secondary street investments
• More $ stays in country for both implementation and operation
• Can fix any “teething” problems at relatively low cost
Advantages of BRT

• In rapidly expanding metropolitan areas, BRT can be an effective tool for inducing sustainable development
  – Can afford to build multiple lines relatively quickly
  – Must begin interaction with land use planners as early as possible
There Is No Single BRT System Prescription

• Use transportation planning analysis to develop BRT system package
  – *Begin with market analysis*
  – *Match markets with service plans, plan for running ways, vehicles, stations, etc.*
Essential ingredients for High Capacity and Performance BRT

- Maximum practical proportion of running way **dedicated exclusively to BRT**
- A “rapid transit” service plan
- Vehicles configured for the market and service
- Stations and terminals configured for the market and service
- Efficient, off-board fare collection
- No gap boarding
- Appropriate ITS applications
Essential ingredients for High Capacity and Performance BRT

• Focus on System Integration
  – Make running ways, service plan, stations, vehicles, fare collection, ITS function as one system
  – Provide a unique, pervasive brand identity and quality image as a passenger information and marketing device
• Be willing to spend money on BRT; in most situations, it can still have life cycle costs orders of magnitude less than any alternative with comparable capacity and performance

  – Resist “de-construction,” the removal of key components because it’s “just a bus
• Work hard to overcome the negative image of most bus “systems”

• Ensure that decision-makers and the general public know what BRT is and what its potential benefits might be for their city