Perspectives on Bus Rapid Transit (BRT) Developments in China

Georges Darido
National BRT Institute
Center for Urban Transportation Research (CUTR)
at the University of South Florida

A presentation to the:
U.S. Department of Transportation
Federal Transit Administration (FTA)
and invited guests

On behalf of the:
FTA Office of Research, Demonstration
and Innovation (TRI)

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Overview of Presentation

- Purpose of trip and meetings
  - FTA Public Transportation Trade Mission to China - April 16-26, 2006
  - Additional BRT/Research meetings
- Background on China’s growth, institutions and policies
- Urban transportation problems and priorities
- BRT systems and plans by city
- Initial findings and next steps
  - Exchange of data and knowledge
  - Areas of potential contribution
  - Areas for further cooperation
- Your Questions and Comments
The main purpose was to visit BRT operating systems and meet with organizations engaged in BRT planning or operations.

- Establish contact and a channel of communications for future cooperation.
- Collect initial data and descriptions of the BRT systems in China in operation and planning:
  - To be included in the updated version of the publication, “Characteristics of Bus Rapid Transit for Decision Making”, to be released in 2007.
  - Expand the understanding of level of service and technology options.
  - Ensure a range of BRT cost and benefits to improve the allocation of limited resources.
- Identify ways to cooperate or collaborate on common problems or programs.

The US approach to BRT planning has been as an integrated system of elements:

- **RUNNING WAYS**
- **STATIONS AND LAND USE**
- **VEHICLES**
- **SERVICE AND OPERATIONS PLAN**
- **FARE COLLECTION**
- **ITS**
- **MARKETING AND BRANDING**
The ten-day visit included meetings with a number of organizations in five cities:

**Beijing**
- Ministry of Construction (MOC), Division of Transport
- China Urban Public Transport Association (CUPTA)
- Municipal Committee of Communications
- Urban Transp. Inst., China Academy of Urban Planning and Design (CAUPD)
- Beijing Transp. Research Center
- Beijing Bus Company and BRT Operator
- Beijing University of Tech.
- Energy Foundation/China Sustainable Transportation Center (CSTC)

**Nanjing**
- Institute of City Transport Planning, Southeast Univ.
- Municipal Construction Committee
- Bus and Metro Companies

**Shanghai**
- Urban Transport Bureau
- Municipal Construction and Transportation Commission
- A Bus company

**Kunming**
- Urban Transport Institute, BRT planners

**Hangzhou**
- Municipal Communications Bureau and Construction Commission
- Transportation Research Center
- BRT Operator
The institutional structure of transportation in China is quite different.
China is experiencing remarkable economic growth and demographic changes affecting urban and public transportation

- Growth of GDP per capita in the past decade has averaged almost 9% per annum and is expected to continue
  - Projected by the government to grow at an annual rate of 8% during the period of the 11th Five-Year Plan (2006-10)

- Demographic change
  - Urbanization (rural migration)
  - Urban spatial decentralization (Prof. Gakenheimer, 2004)
    - Growth of suburbs and land consumption
    - Chinese cities are some of the densest in the world but are decentralizing as government pursues a policy of creating satellite cities

- Mobility effects (Prof. Gakenheimer, 2004)
  - Increasing private vehicle ownership (motorization)
  - Increasing private vehicle use (trip rate: 2-3 trips/person/day)
  - Increasing average trip length due to decentralization
It is projected that China will become the second largest economy by the year 2030

- Size of the economies in 2004:
  - US GDP: $12.6 trillion (largest)
  - China GDP: nearly $2 trillion (6th largest)
- Current exchange: US$1 = 8 Yuan (RMB)
- China is already the second biggest consumer of petroleum in the world after the US (IEA, 2004)
Chinese cities are experiencing rapid motorization and are far from reaching saturation

- Beijing: 2 million private vehicles; 1,000 new private vehicles/day (MOC, 2006)
- US motorized in 60-70 years (~750 veh/1000 pop.)
- Primary reasons:
  - Rising incomes
  - Increased vehicle production and lower prices (domestic auto manufacturing industry)
  - Urbanization and increased congestion

[Graph showing correlation between per capita GDP and cars per 1000 people (logarithmic scale)]

Per capita GDP, 1990 USD converted using Purchasing Power Parity (Logarithmic Scale)

(Dr. Schipper, 2004)
China is urbanizing and decentralizing at the same time, increasing the need for transit

- 150+ Chinese cities with >1 million population
  - Shanghai ~15 million
  - Beijing ~13 million
  - Nanjing ~5 million
  - Hangzhou ~5 million
  - Kunming ~4 million
- 50 US metro areas with >1 million pop. (Census 2004)
- China: urban population ~600 million (40%)
- US: urban and suburban population of ~234 million (80%)

![Figure 3: Distribution of Cities by Population Size](image.png)

(Cherry, 2005)
Urban transportation problems in China are similar to the U.S. but are developing faster and becoming acute

- Growing traffic congestion, delays and productivity loss
  - Average speed in central Beijing and Shanghai decreased by 50% in past 10 years to <10 km/hr (Dr. Zhong-Ren Peng, 2004)

- Worsening air pollution
  - Motor vehicles are now the largest source of urban air pollution in China’s big cities (Dr. Gallagher, 2004)
  - Chinese Vehicle Emission Standards are trying to harmonize with EURO III but still lag several years behind Europe and the US
  - Investing heavily in alternative fuel buses, particularly CNG

- Energy and resource shortage
  - Dependency on petroleum
  - Energy security issues

- Road safety – separation of modes

- Accessibility and mobility for the poor, elderly, and disabled
But there is some optimism for Chinese cities...

- Benefits of using the latest, most cost-effective transportation technologies (i.e., leap-frogging generations of technologies)
  - Existing base is small with a fast rate of growth
  - Reduce fuel consumption and tailpipe emissions
- Parallel of BRT development in China today to Street Cars in early 20th century US (Prof. Gakenheimer, 2004)
  - Less costly alternative to operator and user
  - Safe, low pollution, high throughput
  - Decentralization of cities
  - Competing with metro, private autos, and informal modes
The recent policy of the central government is to give priority to urban public transport

- **State Council Decree #46 (2005)**
  - Policy aimed at increasing transit mode share and absorbing formerly non-motorized trips and new trips
  - The financing of transportation capital projects is done primarily by local governments, with some exceptions
  - The central government will finance more initial urban transportation construction and speed up reform of the urban public transport sector to attract private investors

- **Shanghai and Beijing have comprehensive public transportation plans in anticipation of the 2008 Olympics Games and the 2010 World Expo, respectively**

- **The central government allows metro systems to be developed in cities with populations greater than 3 million**
  - Ambitious rail expansion plans—hopes of attracting private capital
  - At least 15 cities with populations >3 million developed preliminary metro plans or are operating metros (Zhang, 2003)
  - Still, some of these cities and others are pursuing BRT
BRT-type projects are encouraged as a lower-cost rapid transit solution for intermediate to large corridors

- Buses carry the vast majority of motorized trips in Chinese cities (MOC, 2006):
  - 93% of 661 cities in China have bus operations
  - Currently carrying 40 billion trips/year and growing
  - 280,000 buses and trolleys in China and increasing
  - Operating speeds have been decreasing
- At least 10 Chinese cities are actively planning or expanding BRT systems with varying approaches
  - Full-fledged BRT system
  - Incremental implementation of BRT elements
- BRT systems also may be well-suited for many other Chinese cities
Beijing

- Southern Axis BRT Line 1
  - Opened December 2005
  - 16.5 km mostly exclusive, center busway, 19 stations
  - 100,000+ passengers/day
  - 18 month implementation
- By 2008 Olympics Games: 100 km BRT, 186 km metro
- By 2010: 10 BRT lines, 184 km

Images Courtesy of CAUPD and CSTC
Beijing - Southern Axis BRT Line 1

- Center lane busway, some elevated intersections
  - 22-26 km/hr operating speed
- US$4 million/km infrastructure

Images Courtesy of Beijing BRT Co., Ltd, CSTC, and author’s photos
Beijing - Southern Axis BRT Line 1

- New articulated vehicles (Iveco-Chinese JV)
  - 18 meter bus, ~US$250,000 each
- New BRT operating company
- AVL, stop announcement, and video surveillance

Images Courtesy of CAUPD, CSTC, and author’s photos
Beijing - Southern Axis BRT Line 1

- Off-board fare collection
- Fare: 2 RMB (US$0.25)
- Level boarding

Images Courtesy of CAUPD and author’s photos
Beijing BRT

- BRT Program Marketing
- Transit Signal Priority
Shanghai

- Very limited road space for dedicated bus lanes
  - 26 km of bus lanes installed in downtown in 2005
  - Increased speeds by 8-10%
  - Planning TSP and passenger information systems
- AVL on some routes, 1500 buses
- Multimodal contactless smartcard
- By 2010 World Expo:
  - Subway expansion program
  - 250 km BRT network proposed
    - Connect with satellite cities
    - Intermodal terminals
Nanjing

- Incrementally improving bus services
  - Testing AVL/CAD/passenger info systems on 3 routes and 300+ buses
  - Considering stations and TSP to upgrade system
  - Stop announcements
  - Vehicle replacement

- Subway expansion program
Kunming Busway Network

- Launched the first modern busway in China in 1999
  - Kunming-Zurich Sister City partnership
  - "Public Transport Master Plan" with Swiss assistance
  - Ridership on demonstration line increased 13% since inception
  - Average operating speed increased 68% to 15 km/hr
  - Average pass. wait time decreased 59%
  - Reduced fleet size by nearly half
- Currently 40 km network of 6 centerline, dedicated busways
  - 75% coverage of city center
  - 1.2 million passengers per day
  - Capital cost: US$0.5-0.6 million/km
Kunming Busway Network

- Incrementally implementing other BRT elements
  - Upgrading facilities and systems
    - Pass. info signs at stations
    - ITS to improve operations
  - Replacing buses with newer, cleaner vehicles
Kunming Busway Network - Challenges

- Expanding capacity beyond 8,000 passengers/dir./hour
  - Constrained by ROW (lack of space to pass at stations) and intersections
  - Considering TSP and higher capacity vehicles
- Expanding the network beyond the city center
- Improving quality of service
  - Implementing contactless smart cards and free transfers
  - Integration with bus network, passenger terminals
Hangzhou BRT

- First line (B1) opened in April 2006
  - 28 km dedicated bus lane
  - Government funded first line
  - Fare: 4 RMB (US$0.50), regular bus is 2 RMB
  - 16 months of planning and construction
- Hangzhou also constructing a subway by 2010 as part of a 30 billion RMB transportation investment program
Hangzhou BRT

- 48 new articulated buses (18 meters)
  - Neoplan/Chinese JV
  - 160 passengers
- Peak headway: ~2 minutes
Hangzhou BRT

- BRT stations are 150 meters from intersections
- Dedicated right lane with minimal physical separation
Hangzhou BRT

- AVL/CAD
- 450 electronic signs at stops
- 200 bus stops in city center with real-time passenger information
Hangzhou BRT

- Public information
- Smartcard fare collection
Hangzhou BRT Program

- By 2006: 3 BRT lines, 55 km
- By 2010: 9 BRT lines, 142 km
- By 2020: 11 BRT line, 165 km
## Summary of BRT technical characteristics in select Chinese cities

<table>
<thead>
<tr>
<th></th>
<th>Beijing</th>
<th>Kunming</th>
<th>Hangzhou</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bus lane position</strong></td>
<td>Center, with barriers</td>
<td>Center, 5 cm barrier</td>
<td>Right, limited low barriers</td>
</tr>
<tr>
<td><strong>Bus lane width</strong></td>
<td>3.5 m</td>
<td>3.2 m</td>
<td>3.5 m</td>
</tr>
<tr>
<td><strong>Vehicles</strong></td>
<td>18 meter low-floor</td>
<td>9-12 meter high-floor</td>
<td>18 meter low-floor</td>
</tr>
<tr>
<td><strong>TSP</strong></td>
<td>yes</td>
<td>no</td>
<td>SCATS</td>
</tr>
<tr>
<td><strong>Real-time pass. info.</strong></td>
<td>yes</td>
<td>Implementing</td>
<td>yes</td>
</tr>
<tr>
<td><strong>Fare collection</strong></td>
<td>Pre-payment</td>
<td>On-board</td>
<td>Pre-payment, smartcard</td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td>New BRT company</td>
<td>Existing organization and operators</td>
<td>Existing organization and operators</td>
</tr>
<tr>
<td><strong>Development pattern</strong></td>
<td>Secondary passenger corridor for city and TOD</td>
<td>Network</td>
<td>Connects the city center and periphery</td>
</tr>
<tr>
<td><strong>Financing</strong></td>
<td>Shared government and BRT company</td>
<td>Operator responsible for maintenance, signals and stations</td>
<td>Government-- including construction, vehicles, ITS</td>
</tr>
</tbody>
</table>

Source: CAUPD, April 2006
There are several other Chinese cities planning or implementing BRT

- **Jinan** – under construction
  - 2010: 6 BRT lines, 135 km
  - 2020: 12 BRT lines, 208 km
- **Guangzhou** – evaluation stage
- According to CAUPD, BRT also planned:
  - Chengdu
  - Chongqing
  - Fuzhou
  - Hefei
  - Qingdao
  - Shenyang
  - Shenzhen
  - Shijiazhuang
  - Suzhou
  - Tianjin
  - Wuhan
  - Xi’an
  - Zhengzhou

Proposed BRT in Jinan courtesy of CAUPD
There is a lot of BRT activity in Chinese cities, which are good laboratories for research

- According to CAUPD as of 2006: 969 km of BRT is planned
  - 137 km is under construction now
  - 39 km will be under construction
- The development time is compressed
  - Typical implementation from planning to opening of <2 years
  - Impacts of BRT projects on land use, economic development, and environmental quality may be observable in much less time
- There are a variety of approaches being pursued
- Transit ridership is likely to grow quickly
- Being mindful of the significant differences in the decision-making processes and what is considered standard practice
- Possibility of greatly enhancing the CBRT data set, e.g.
  - CAUPD: BRT before/after study in Beijing, perhaps others
  - CSTC: Alternative fuels program
There are a number of BRT systems operating or being planned in the US

**Evaluated...**
- Los Angeles
- Miami
- Orlando
- Pittsburgh
- Las Vegas
- Boston

**Evaluating...**
- Oakland, Calif.
- Honolulu
It may be an opportune time to pursue the formal or informal exchange of BRT data.
There are also research areas where the US can make contributions to its counterparts

- Federal funding process and innovative financing options
  - Selection and administration of funds (e.g. New Starts, Small Starts)
  - Public-Private Partnerships and Design-Build arrangements
- Coordination of transportation agencies and regional planning
- Technology acceptance
  - VAA for narrow lanes and shoulders, etc.
  - VII for mobility and safety
- Network optimization
  - TSP to improve capacity and operations
  - Integration of bus-BRT-rail to minimize transfers and improve services
- Demand-oriented planning
  - One criticism of current Chinese policy is that it favors supply-oriented transportation development strategies and overlook fundamental modes such as bus, biking, and walking
  - Socially desirable services to urban poor and disabled
Other means for further collaboration are also developing

- APTA/CUPTA agreement signed in April 2006
  - CUPTA new committees: ITS and BRT
- FTA negotiating agreement with Chinese Ministry of Construction
- US and China part of the Asia-Pacific Partnership on Clean Development and Climate
  - Advanced transportation technologies (e.g. vehicles, ITS)
  - Alternative fuels
- USF-CUTR/Veolia working on agreement to train Chinese transportation students in Tampa, Florida
Acknowledgements

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- Officials met from the Chinese central government, municipal agencies, and universities in Beijing, Nanjing, Shanghai, Kunming, and Hangzhou
- NGOs – ITDP, Energy Foundation/CSTC, WRI/Embarq
Thank you for your attention.
Questions and Comments

For more information:

Mr. Venkat Pindiprolu
Service Innovation Team Leader
FTA Office of Mobility Innovation
venkat.pindiprolu@fta.dot.gov
Tel: +1-202-366-8061

Mr. Georges Darido
National BRT Institute, CUTR, USF
darido@cutr.usf.edu
Mobile: +1-407-902-8544