

# Addressing mobility challenges in Brazilian cities: exciting technologies for new rail projects

**Francisco Garcia**  
Director Business Development, Systems Division  
Bombardier Transportation

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# Mobility challenges for world cities

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**Urbanization**

Continuous growth of cities – high traffic congestion in urban areas

**Energy cost increase**

Usage of energy goes up, availability of fossil energy is decreasing

**Global Warming**

Most likely effect of the man-made greenhouse gas concentration<sup>(1)</sup>

**Demographic change**

Low birth and death rates lead to aging of the population

**Construction Costs**

Cost of underground Metros can reach anywhere between \$90 - \$135 million/km

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**1 Mobility challenges for world cities**

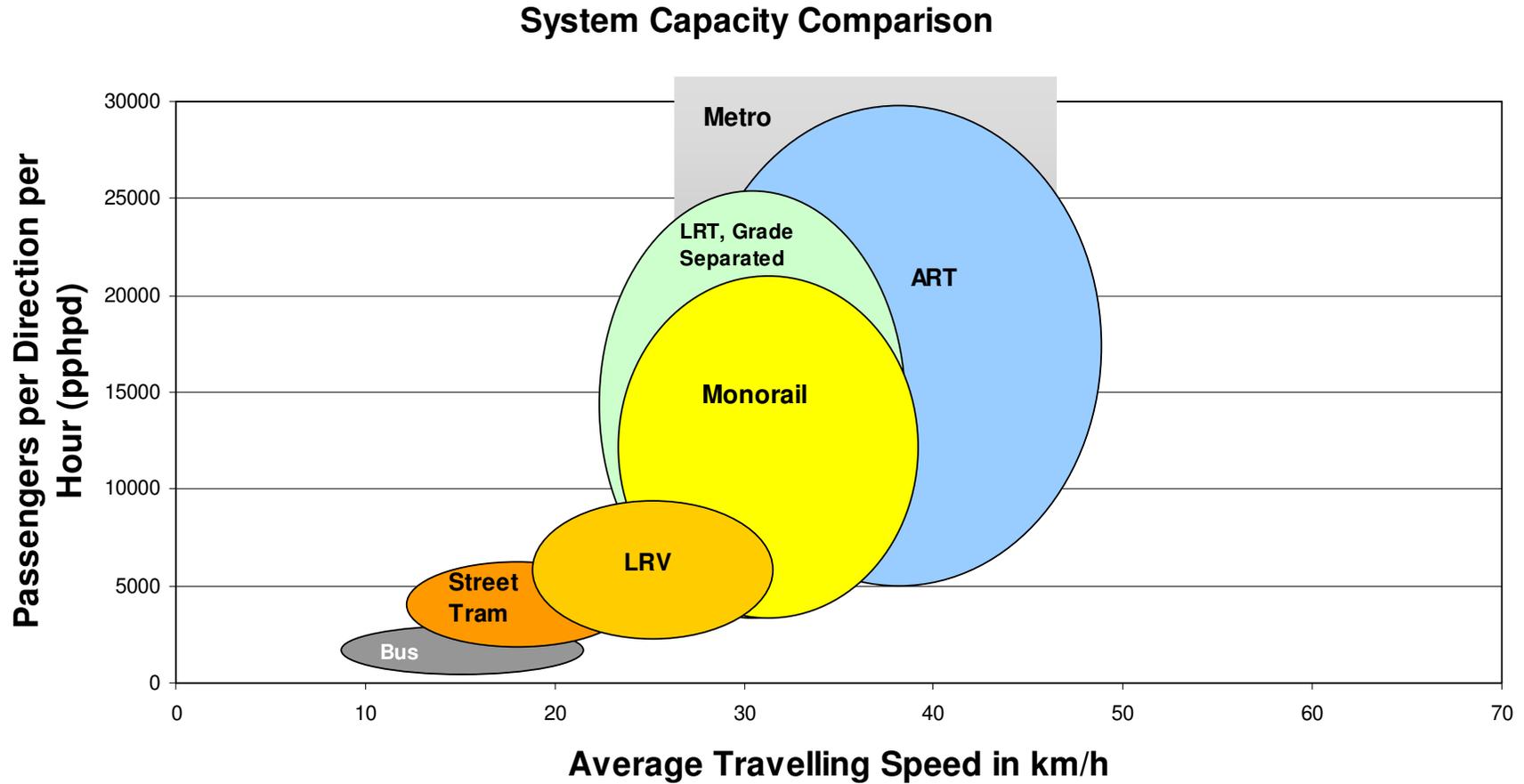
**2 Three technology options for new rail developments**

**3 Taking a total system approach**

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# System Capacity Comparison



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LRT (grade separated), ART and Monorail added by TTS, Bombardier

Source: SCI Verkehr

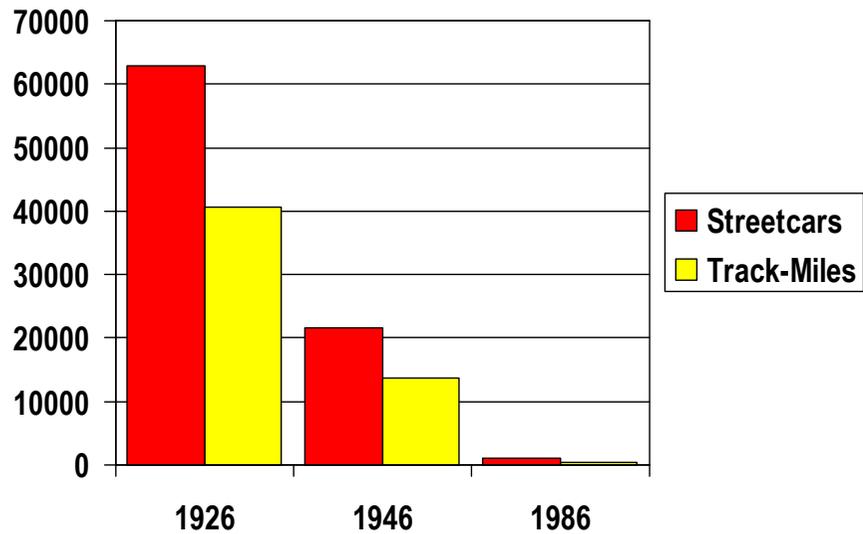
Note: Average travelling speed, also called commercial speed is the average end-to-end speed including stops.

# Comparative Matrix

	<b>Street-Running Light Rail</b>	<b>Elevated Light Rail</b>	<b>Underground Metro</b>
<b>Capacity Range (thousands of pphpd)</b>	4 - 8	7 - 30	30 - 80
<b>System Cost (millions of US\$ per km)</b>	9 - 25	30 - 65	90 - 135
<b>Commercial Speed (km/h)</b>	10 - 20	30 - 40	35 - 40
<b>Accessibility to Pedestrians</b>	best	intermediate	poorest

# Option 1 ) The Light Rail alternative / History

- Streetcars have had a long history in North America
- Enjoyed rapid growth near end of 19th century and start of 20th century
- At peak, every city of 5,000 persons or more had at least one streetcar line
- However, in 2 decades after W W II, majority of streetcars removed in favour of automobiles



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# The Light Rail Metro alternative

- **Advantages of rail-bound transport solutions**

- Reduction of individual car traffic
  - Reduction of traffic volume
  - Reduction of pollution and noise exposure
  - Reduction of costs for repair and maintenance of roads
- Increase of mobility
  - Attractiveness through quick connections
  - Environmentally friendly transportation (effects on tourism, urban development,...)
  - Extension and interconnection of inner-city transport with overland traffic



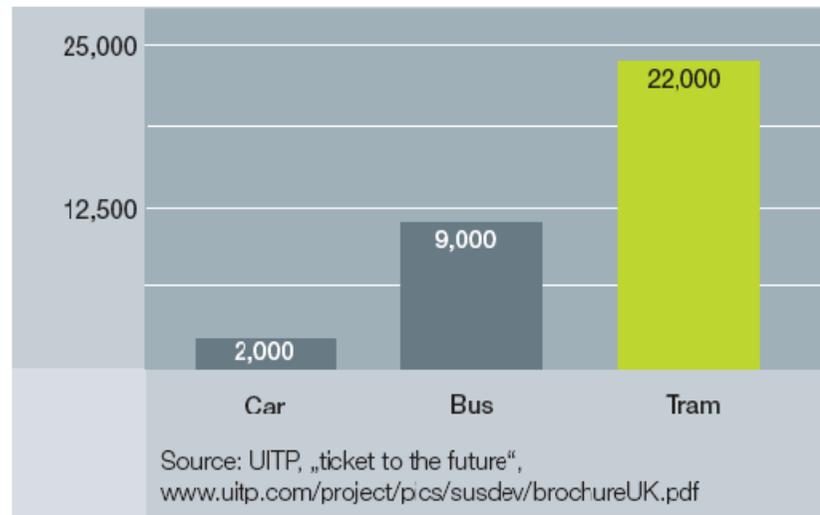
- **Realised by**

- Trams
- Light Rail Vehicles
- Metros



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# Transforming cities with light rail systems



Number of people crossing a 3-5 m wide space in an urban environment during a 1 hour period:

## Ultra-modern designs

- Vehicle design to reflect the city's characteristics
- Modular technology with many pre-planned options to meet customers' exacting requirements
- Integration into existing transport networks
- Accessible for all – low-floor technology and good connections

## Most energy efficient transport

- Well-patronised light rail vehicles have a much lower energy consumption per passenger than cars and buses

# The BOMBARDIER *FLEXITY* Family

<i>Trams / (Streetcars)</i>		<i>Light Rail Vehicles</i>	
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**BOMBARDIER  
*FLEXITY* Outlook**

- 100% low floor trams with proven axle wheelset bogies



**BOMBARDIER  
*FLEXITY* Classic**

- 70% low-floor trams with low-floor entrances at all passenger doors



**BOMBARDIER  
*FLEXITY* Swift**

- Low-floor and high-floor citytram vehicles



**BOMBARDIER  
*FLEXITY* Link**

- Tram-train solution for dual voltage operation



***Bombardier FLEXITY Berlin***

- 100 % low-floor trams for the German capital



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# BOMBARDIER *FLEXITY* Outlook, Brussels Canada Olympic Line

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- **October 12, 2009 – Departure of the streetcars from Belgium**
- **December 05, 2009 – Delivery of the streetcars to Vancouver**
- **December 05, 2009 to January 20, 2010  
Testing and commissioning of the streetcars on the Olympic Line**
- **January 21, 2010 to March 21, 2010  
Olympic Line operation**
- [Brussels video](#)



# Option 2) Advanced Rapid Transit ART-

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Vancouver



Detroit



New York



Kuala Lumpur



Korea

**BOMBARDIER**

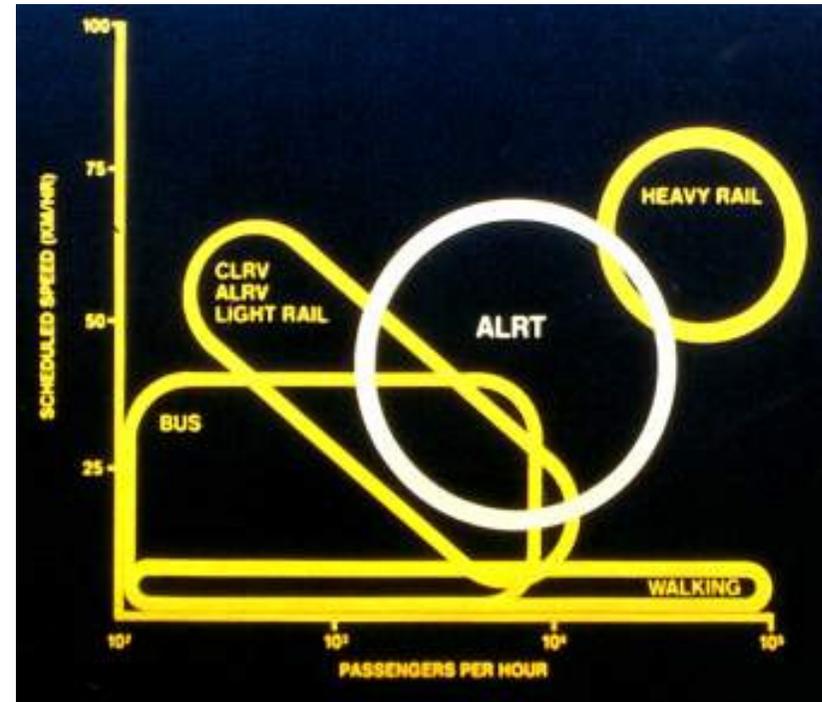
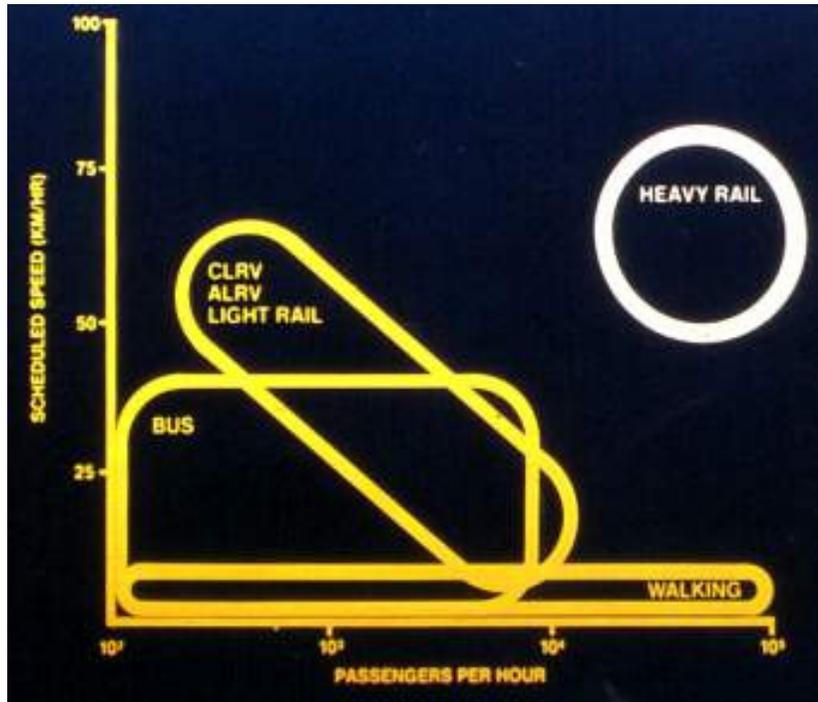
# Origins of ART

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- **Development dates back to 70's**
- **ART was developed to specifically meet intermediate capacity requirements**
- **Revolutionary Linear Induction Motor (LIM) propulsion, radial steering bogie and communications-based moving block train control enables fully automated driverless train operation**

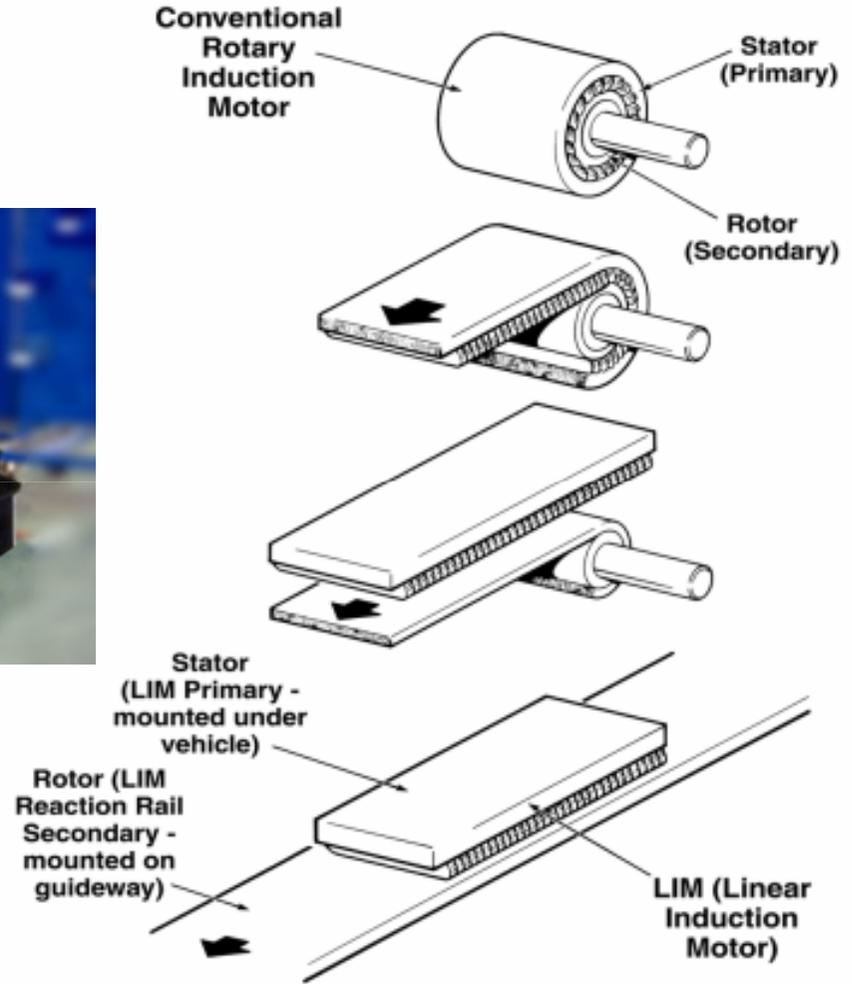
# ART Fills the gap between.....

street-running trams and LRV systems (low-medium capacity)  
and heavy rail metros (high capacity)



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# From conventional rotary motor..... to linear induction motor



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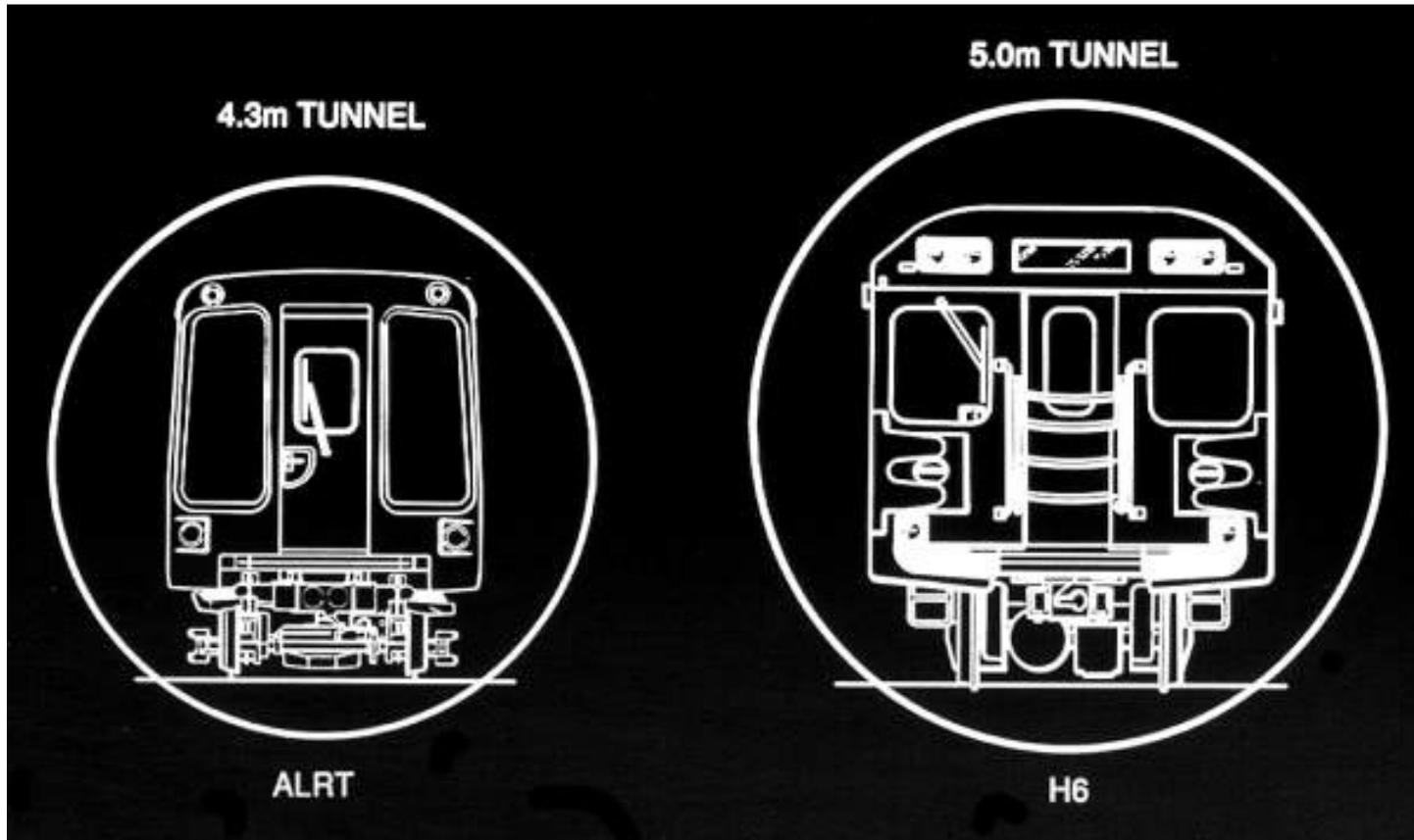
# Lower tunnel construction costs

- **Low profile vehicles requires small diameter tunnels**
- **½ meter reduction can reduce tunnel construction costs by up to 25%**



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# Tunnel diameter comparison



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# Aesthetic elevated guideways: Smaller footprint



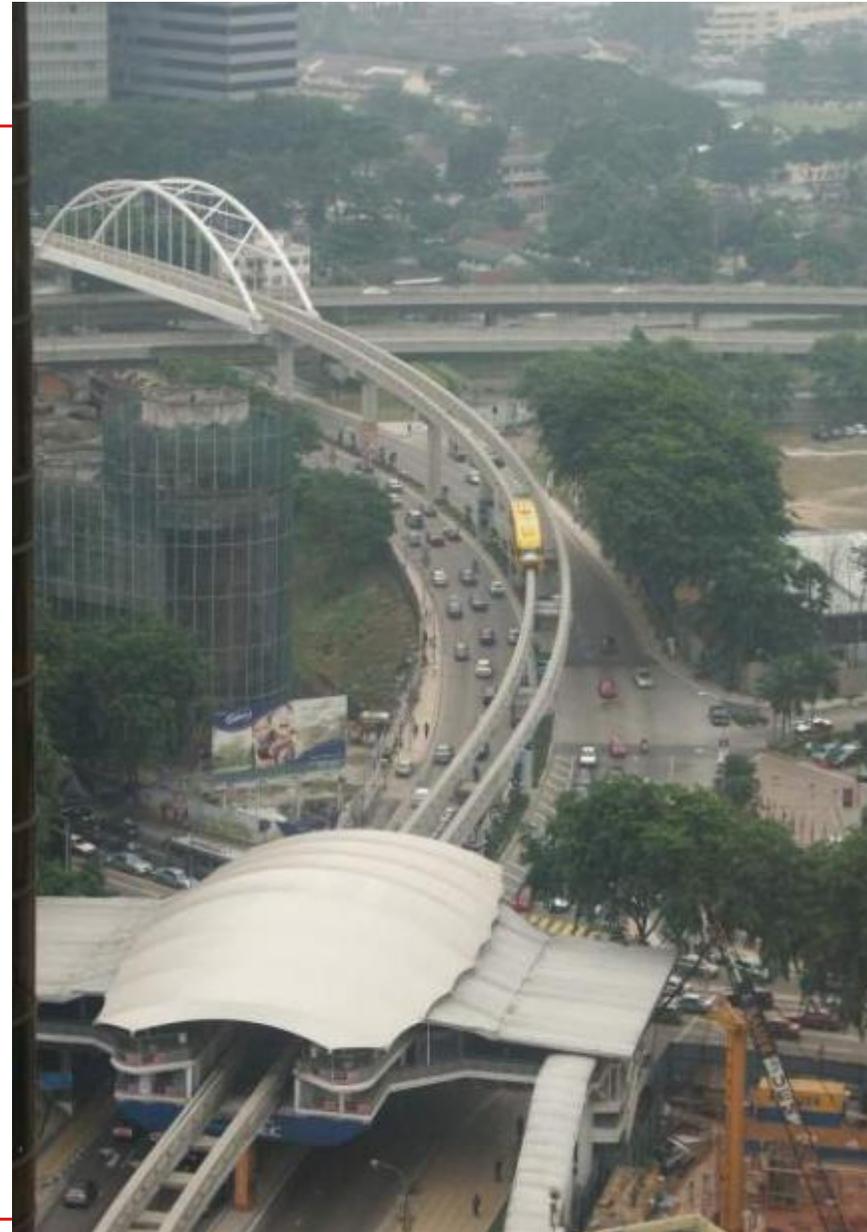
# Option 3) Monorail



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# Why Monorail?

- **If Aesthetics are the Primary Consideration**
  - Vehicle Aesthetics
  - Guideway Aesthetics
- **For Low - Intermediate –high capacities**
  - 2,000 - 20,000- 40,000 pphpd
- **Where at-grade /elevated running is not acceptable or affordable**
  - Elevated Guideway is Required
- **For Reduced construction cost & construction Time**



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# Bombardier Monorail Project Experience

Product Type	Project	Application	Operation	
Las Vegas	Las Vegas Monorail (6.4 km / 7 stations)	Mass Transit	2004	
Type UM-III	Tampa 1 km / 8 stations	APM	1991	
Type 3A (Von Roll)	Newark 4.67 km / 8 stations	APM	1996	
Type UM-III	Jacksonville 6.9 km / 8 stations	APM	1998	

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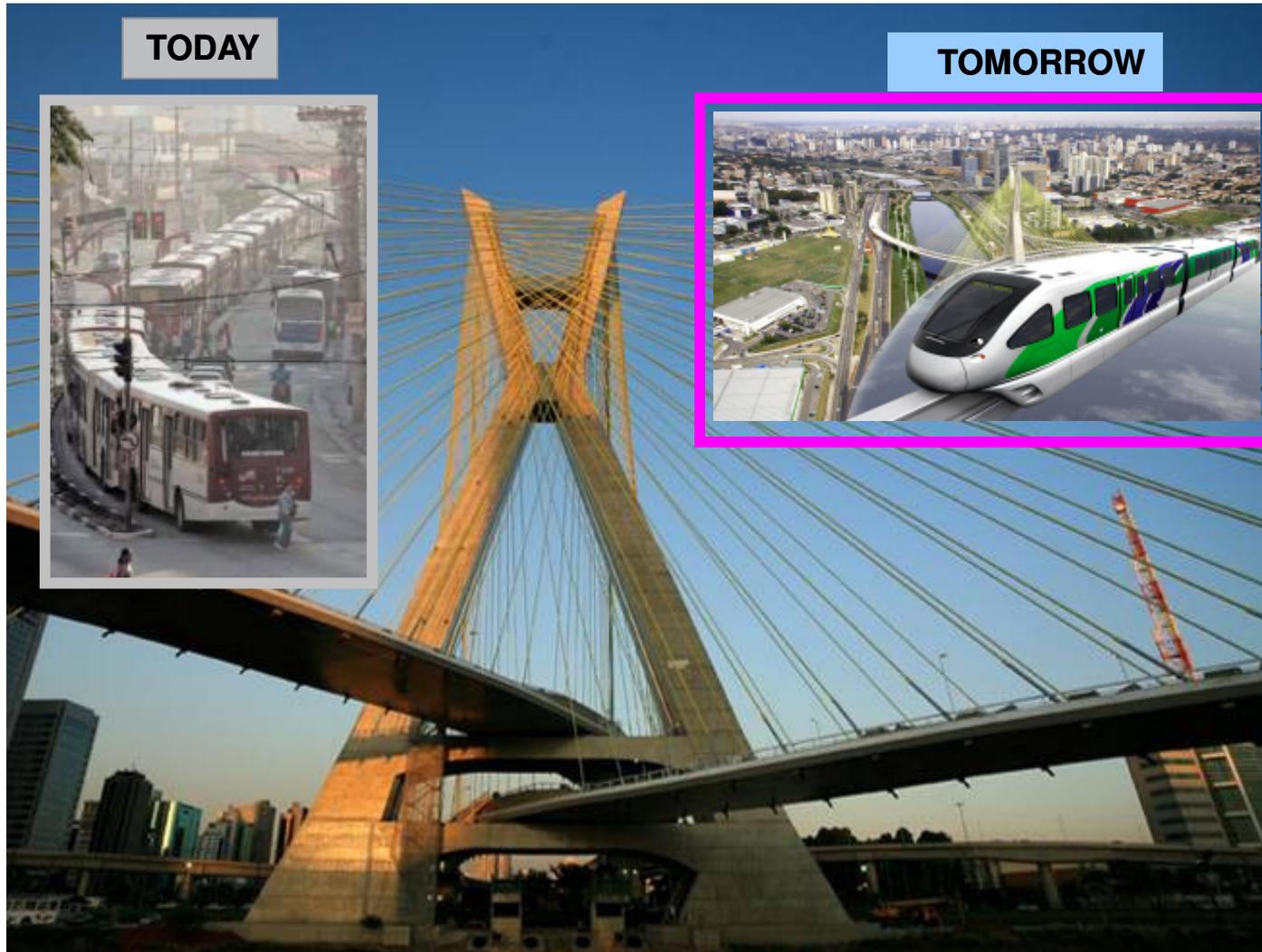
# Las Vegas Monorail – USA



- Fully automated, driverless Monorail System
- Revenue service: 2004
- 9 four-car trains
- Design capacity: 3,200 pphpd
- Links 8 major resort properties and the Las Vegas Convention Centre
- 6.4 km dual-beam alignment
- 7 stations
- Maximum grade: 6.5%
- Guideway-mounted power rails, 750 Vdc
- Operations and maintenance
- Public Private Partnership
- 46 m minimum curve radius on the mainline

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# Public Transportation in the City of Sao Paulo and the Metropolitan Region



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# Bombardier Monorail – State-of- the-art experience



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# Bombardier Monorail – Urban Fit



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## Bombardier Monorail – Interior arrangements



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## Bombardier Monorail - Handicapped Accessible (ADA)



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# Rescue Measures in Major Incident

For major incident such as on-board fire, safe evacuation must not rely on active intervention or assume that traction power is available for a recovery train.



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Only a system-wide emergency walkway can reliably protect passenger safety in major incidents. (Designed to NFPA130)

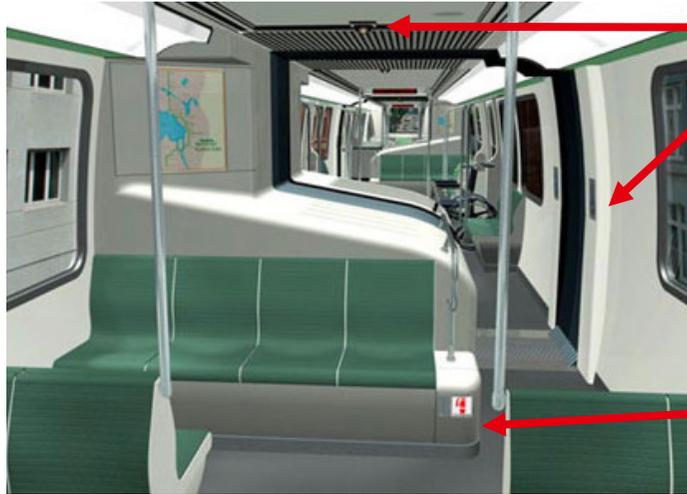
# Rescue Measures in Major Incident: Consequences of no emergency walkway

- **Assume that a fire incident occurs similar to Alweg Monorail in Spring 2004 – Seattle USA**
  
- **Alweg Incident – Spring 2004**
  - Under car fire occurred at inter-car location.
  - Unable to evacuate to parallel vehicle due to excessive smoke
  - Fortunate that vehicle was in an accessible location for fire truck ladder
  - Many treated for smoke inhalation injury

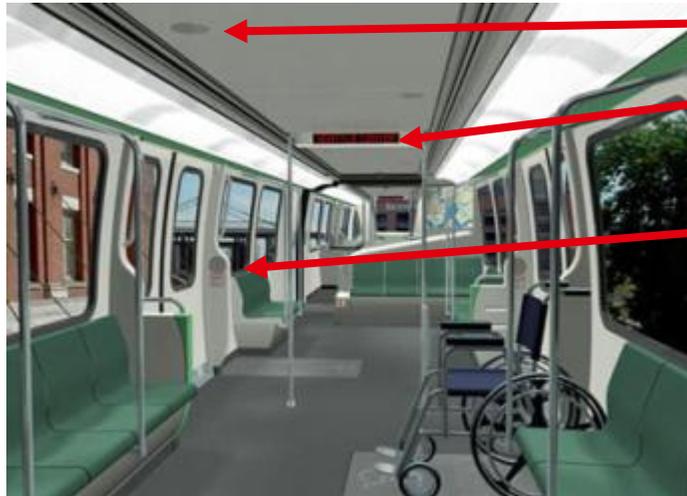
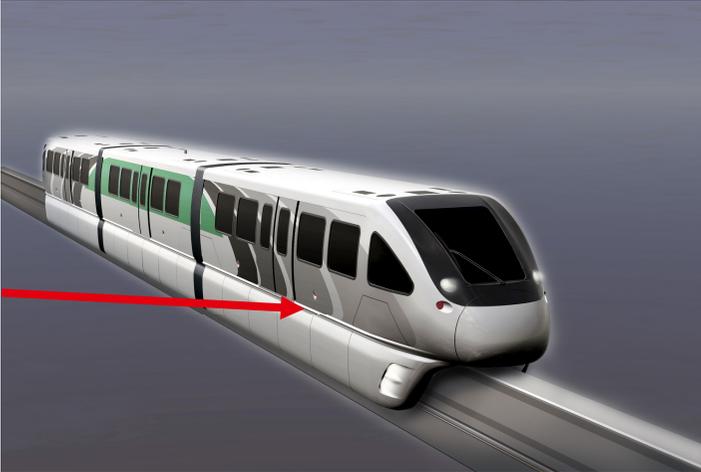


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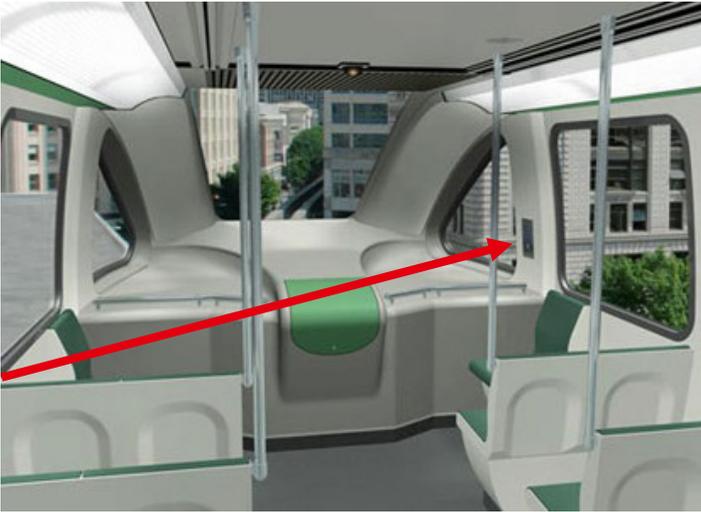
# Bombardier Monorail - On Board Emergency Features



- CCTV
- Intercom / Passenger Assistance
- Emergency Door Release
- Fire Extinguisher

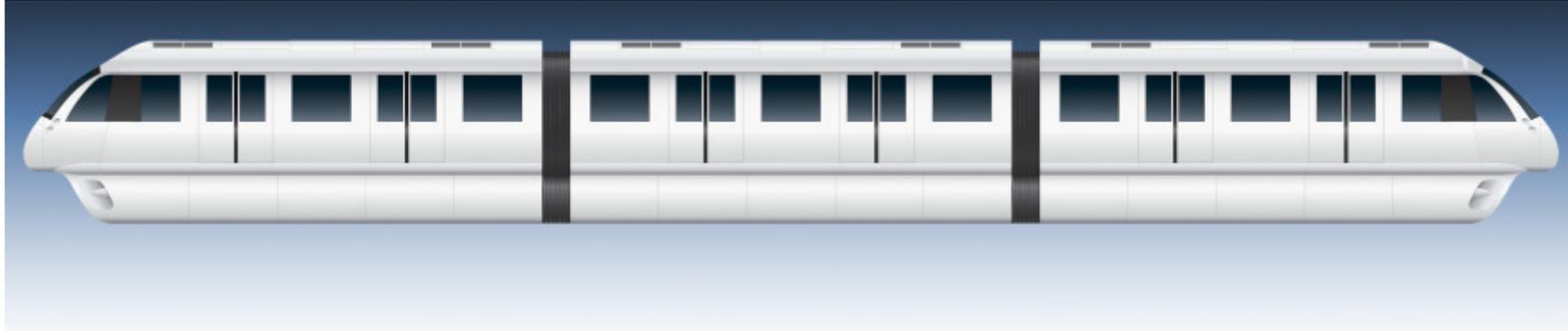


- Speakers
- Passenger Information Display
- Emergency Door Release
- Intercom / Passenger Assistance



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# Bombardier SP Monorail - Automatic Train Operation Benefits



## Bombardier Driverless Technology is capable of 90 sec headways

- **Reduced Headway enables:**
  - Maximized average train speed
  - Minimized train lengths
  - Minimized platform length and Civil station costs
  - Optimized fleet size
  - Reduced area of storage and maintenance facilities
  - Initial platform length @ 20000 pphpd can be as low as 30 m (3-car monorail)
- **Reduced O&M costs**
- **Reduced energy consumption**
- **Frequent, safe and reliable service is attracting more passengers and generating more revenue**

# Bombardier Monorail – State-of- the-art experience



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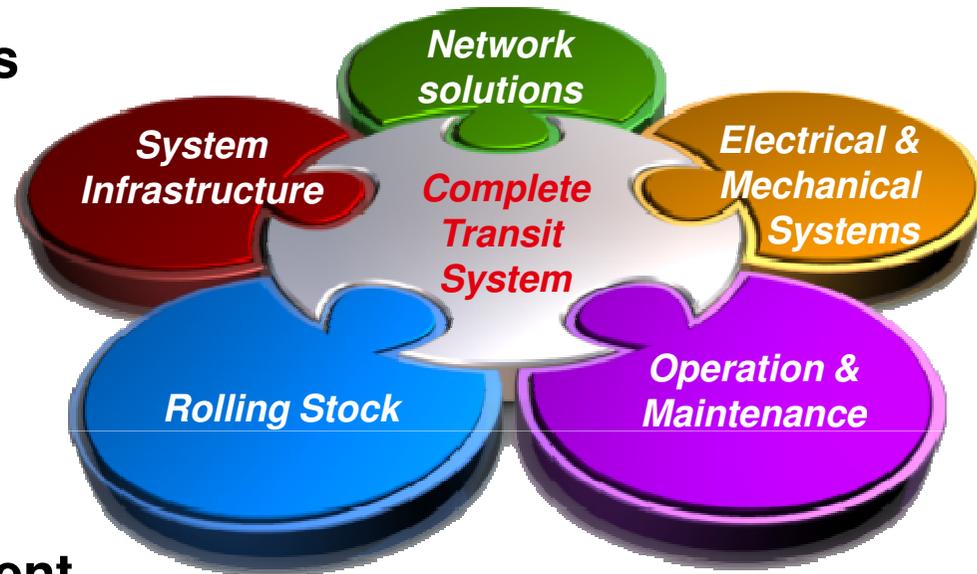
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# System integration for a successful end-to-end solution

**“The whole is greater than the sum of its parts”**

- One party ‘oversees’ activities of the multi-disciplinary parties involved
- Complexity of a rail transit system needs strong project management to integrate the sub-systems at the right time
- Enables controlled management of any changes → no surprises
- Provides staged milestones preventing sudden, high-risk exposures
- It makes good business sense → clients are guaranteed an integrated, operational transit system



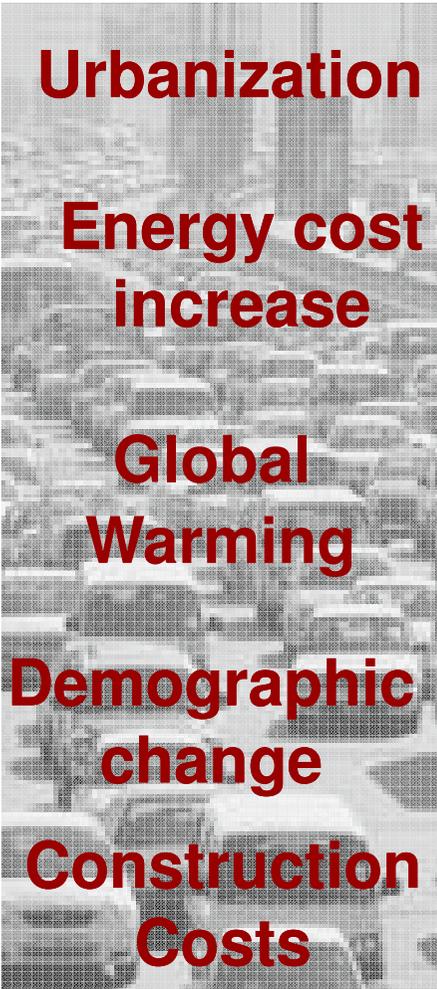
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# Mobility challenges for Brazilian cities



**Innovative transit systems ensure that megacities do not collapse under road traffic.**

**Eco-friendly technologies significantly reduce the energy demand of a train.**

**Modern electric trains produce zero CO2 and no particle emissions (2).**

**Modern and attractive rail systems and vehicles with comfortable interiors suitable for all.**

**Medium capacity/elevated systems offer effective and yet affordable transportation solutions.**

# Sao Paulo Monorail – Video Presentation



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