



## **Smart and Sustainable Transport Solutions**

*Increase Capacity and Reduce Environmental Footprint*

**David Allen**

**Vice President – Asia Pacific & Australia Region**

**Systems Division**

**Bombardier Transportation**

National Summit on Public Transport  
Kuala Lumpur

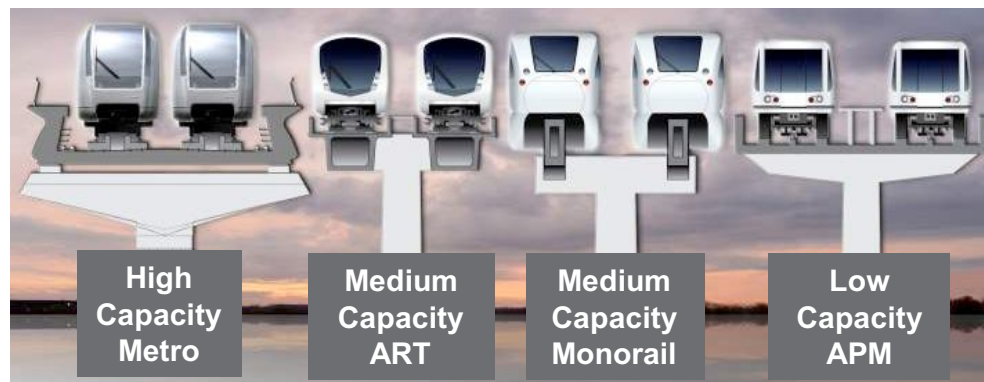
**BOMBARDIER**

# Increase capacity and reduce environmental footprint

---

Traditional views of system design are:

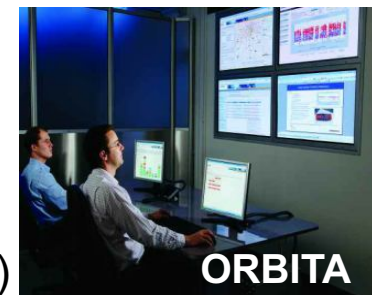
- Rolling Stock technology is adapted to specific transport capacity (in terms of PPHPD)
- Once the system is installed, transport capacity is fixed
- To transport more passengers you need to use more resources, especially more energy
- More passengers means a greater impact on the environment



- New technologies, new Build and Design requirements as well as changing operational requirements are blurring this vision

# Principal ways to increase capacity

- **Select a higher capacity transit system (in PPHPD)**
- **Transport more people within a given dynamic envelope**
  - New train technology
  - Train arrangement and design
  - Upgradeability in terms of train configuration
- **Make your assets work harder**
  - Fleet availability
  - Sub-system reliability
  - Reduced down-time (dual power)
- **Optimise your operation**
  - Focus on optimising schedule
- **Run shorter headways**
  - Select the right propulsion and signalling technology
  - Reduce dwell times (platform doors / optimised train doors)



© Bombardier Inc. or its subsidiaries. All rights reserved.

# Principal ways to reduce environmental footprint

- **Design systems to minimize impact on environment**

- Focus on right of way and land usage
- Seek noise and vibration limitation

- **Consume less resources**

- Select the right technology
- Streamline the fleet size
- Optimize the traction energy architecture
- Optimize fleet trips

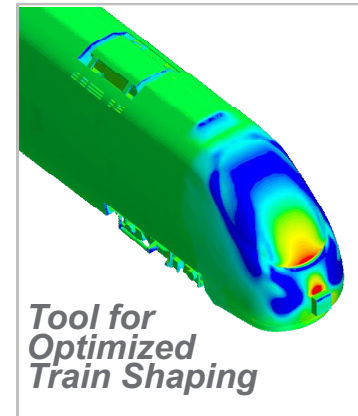
- **Consume resources more efficiently**

- Reduce electrical energy losses
- Improve rolling stock efficiency
  - Aerodynamic and rail resistance optimization
- Optimize operations and maintenance
- Improving driving behaviour
- Manage energy

- **Recuperate (energy) and recycle**



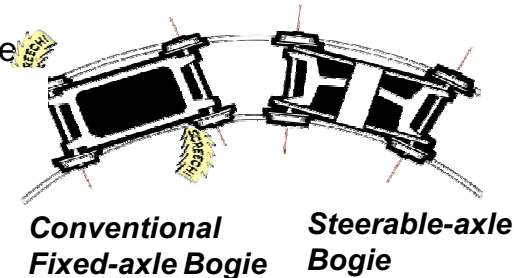
$$w = A + Bv + Cv^2$$



© Bombardier Inc. or its subsidiaries. All rights reserved.

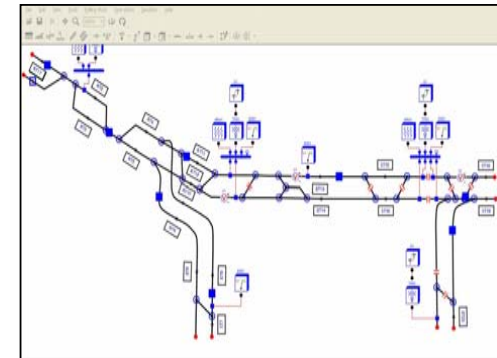
# Design system for high capacity and small environmental footprint

- **Reduced land usage**
  - Reduced right of way by using Monorail
    - One single beam, which can be fitted along existing roads
    - High capacity is achievable with Monorail
- **Urban fit**
  - LIM technology enables:
    - Steeper grade: >8%; Small radius curve;
    - Faster in and out of tunnels; Smaller tunnel diameter
- **Reduced Noise, Wear and Vibration**
  - Anti-noise and anti-vibration track work fixings; Continuously welded rail; Moveable frogs; Steerable bogie
- **System Design for Environment**
  - Station energy consumption optimization
    - Usage of natural light; Electrical shut down according to usage (offices, elevators, etc).
    - Dimming to maintain LUX requirement
    - Use of LEDs in stations
- **Rolling Stock Design for Environment**
  - Recyclability; Propulsion design; Lightweight vehicle

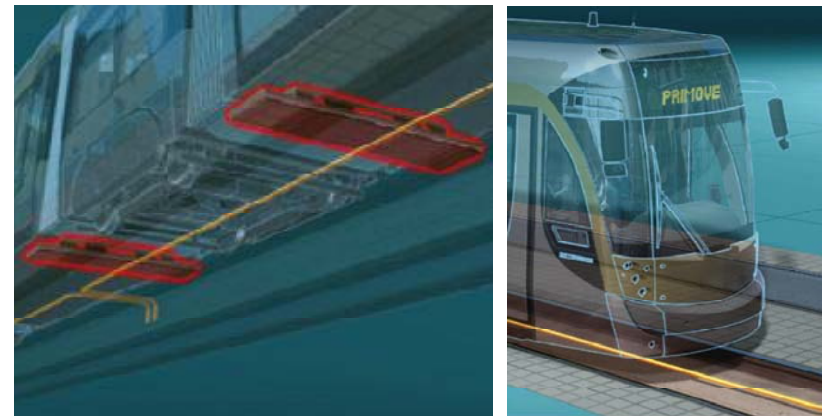


# Design system for high capacity and small environmental footprint

- **Energy consumption modelling**
  - Simulating energy flows of whole systems
    - For complete fleets and on multiple routes
  - Enabling the optimization of:
    - Drive performance; train schedule; power supply; distribution system
- **Way-side energy loss reduction**
  - Right cable section; Third rail with better resistivity; Reduced heating system (LIM)
- **Way-side energy storage**
  - Super capacitors, Fly-wheel, Line converters
- **Catenary Free Operation**
  - Induction technology for unlimited CFO
  - Supercaps and batteries for limited CFO



**EnerGPlan**



**PRIMOVE Catenary Free Operation**

# Design trains to carry more people per kilometre

- **Increase further heavy metro capacity**

- Optimized seating arrangement
- Reduced equipment space
- Single versus Bi-level technology
- Intelligent interior design
- Trains with gangways
- Better passenger flow (wider door)
- Higher pax/ m<sup>2</sup> tolerance



**Porteur Haute Densité**

- **Adopt light-weight high-capacity technology**

- High capacity with smaller dynamic envelope
  - INNOVIA ART 200 (3.2m wide x 17m long and low height)
  - LIM technology with reduced rotating masses



**INNOVIA ART 200 (3.2m wide)**

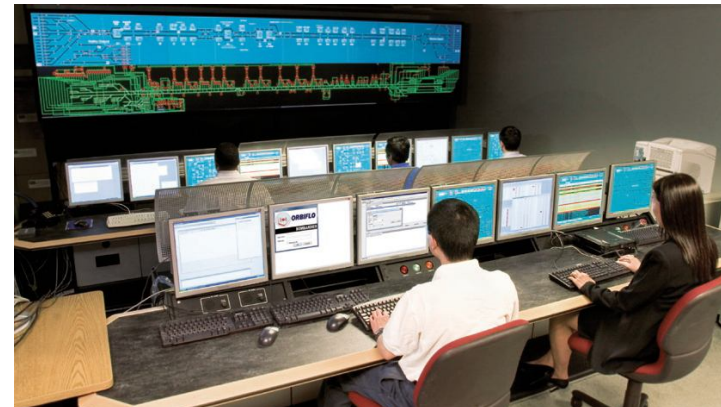
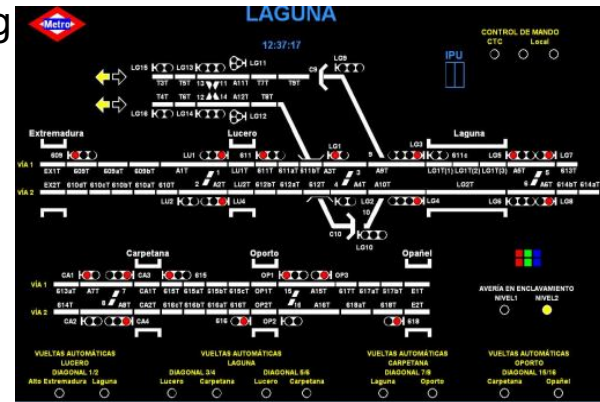
- **Use flexible configuration**

- Plan system evolution
  - Station length will limit expansion
- Automatic coupling can increase capacity
  - While adapting to peak and off-peak requirements

© Bombardier Inc. or its subsidiaries. All rights reserved.

# Design the system to carry more passengers with same Rolling Stock and Infrastructure resources

- **CBTC 60-second headway**
  - Full moving block technology
  - Occupation and positioning is given by the train using bidirectional com technology to way-side equipment
  - Train separation is only limited by virtual train occupation and status of switches
  - Can be used for greenfield or brownfield systems
- **Reduced head-way**
  - Track brakes on LIM technology
  - Faster accelerating / decelerating performance
  - Station platform door
- **Make your assets work more**
  - Increase system availability
  - Increase sub-system reliability
  - Reduced down-time
    - Easier maintainability, greater testability, remote condition monitoring



© Bombardier Inc. or its subsidiaries. All rights reserved.

# Improved Rolling Stock efficiency

## ■ Onboard super capacitors

- Store electrical energy on-board and re-use it, whenever needed
- Increase traffic volume through higher acceleration
- Eliminate Diesel emission in stations (DEMU)

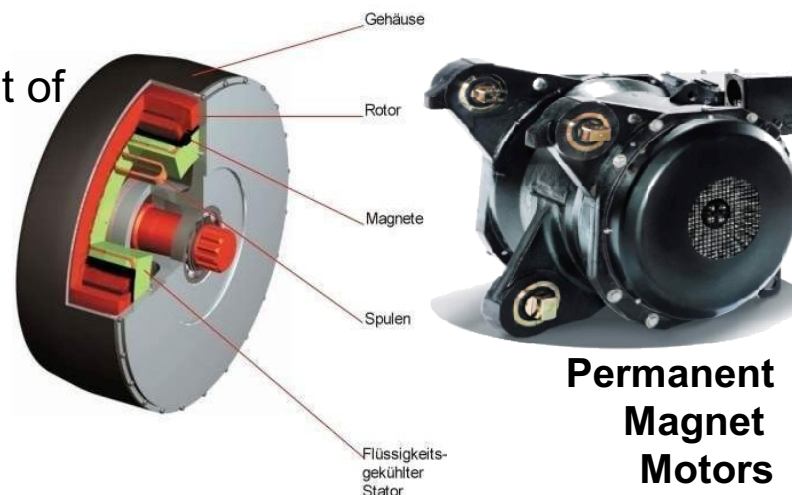
## ■ Permanent Magnet Motor

- Same outer dimensions
- Maximum tractive effort superior to that of comparable induction motor
- Increased vehicle performance
- Optimized energy efficiency
- Reduced volume and weight

## ■ Optimized traction chain



**MITRAC  
Energy  
Saver**



**Permanent  
Magnet  
Motors**

© Bombardier Inc. or its subsidiaries. All rights reserved.

# Improved Rolling Stock efficiency

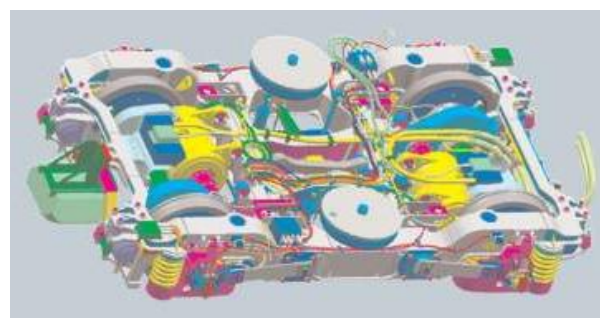
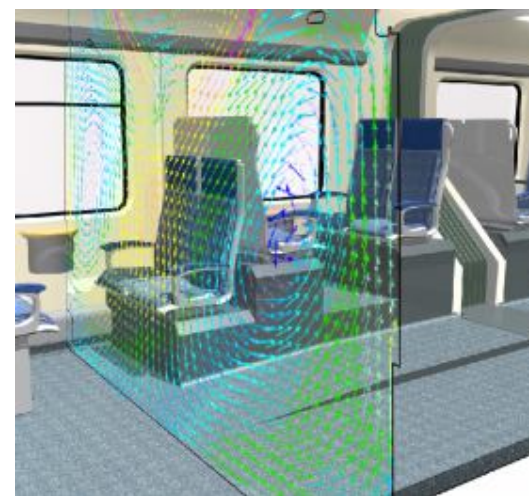
---

## ■ Thermo-Efficiency

- Managing HVAC Energy Consumption
  - Transferring exhaust air energy into the air which is blown into the cabin
  - Measuring the numbers of passengers and supplying the right amount of fresh air

## ■ Intelligent and Active Bogie

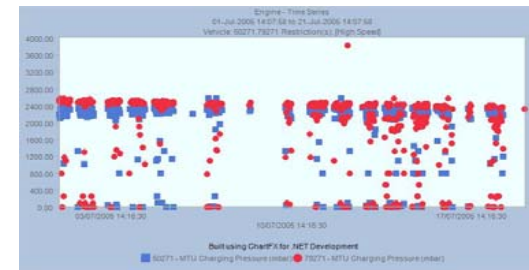
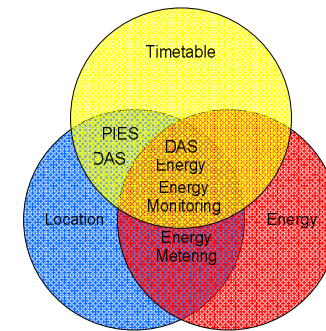
- Active steering bogie, controlling train stability
- Automatic adaptation to changing operating conditions:
  - Higher speed, tighter curves, different track parameters
- Reduced noise emission and vibration transmission, as well as reduced train weight



© Bombardier Inc. or its subsidiaries. All rights reserved.

# Optimize operations to increase capacity and reduce resource consumption

- **Efficient time tabling**
  - Possibility to share information to increase capacity while reducing energy
- **Partial route operation**
- **RTO (Remote Train Operation)**
  - Enable faster availability of vehicles
- **Condition based maintenance**
  - Reduce the downtime availability of trains



System Engineers analyze data of the turbocharger outlet pressure and tag as a potential failure...



... which is then confirmed by Maintenance Engineers

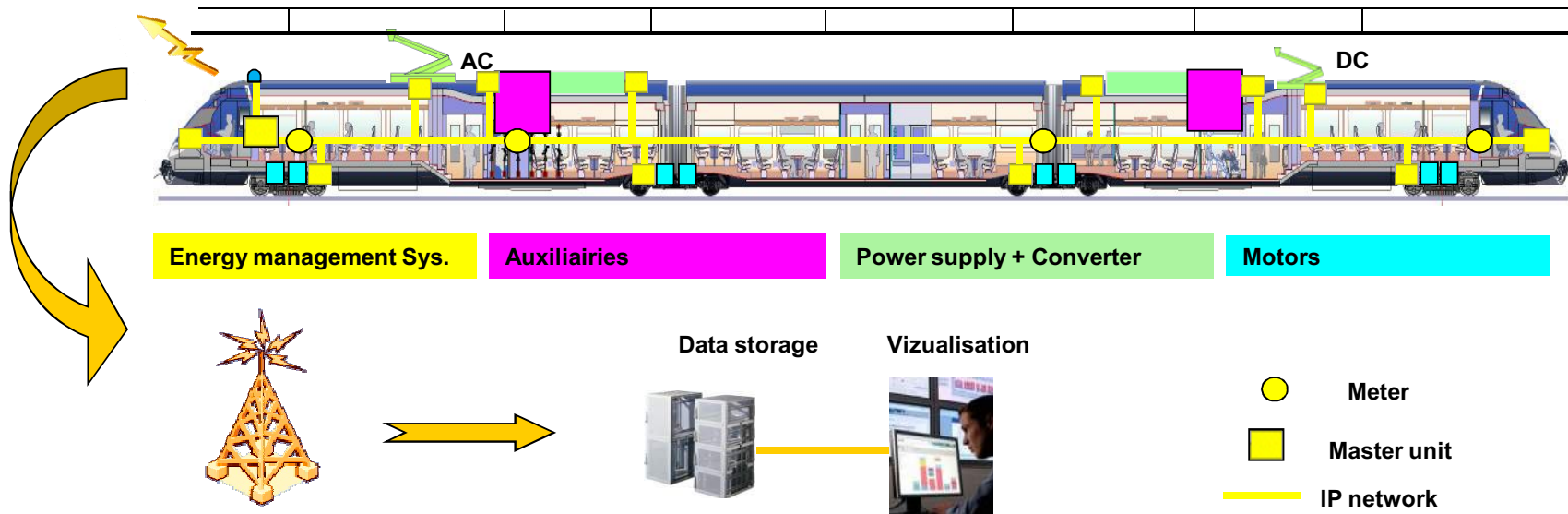
# Optimize operations to increase capacity and reduce resource consumption

- **Smart stabling**

- Reduce unnecessary auxiliary loads at turnaround, inter-peak and overnight

- **Energy management**

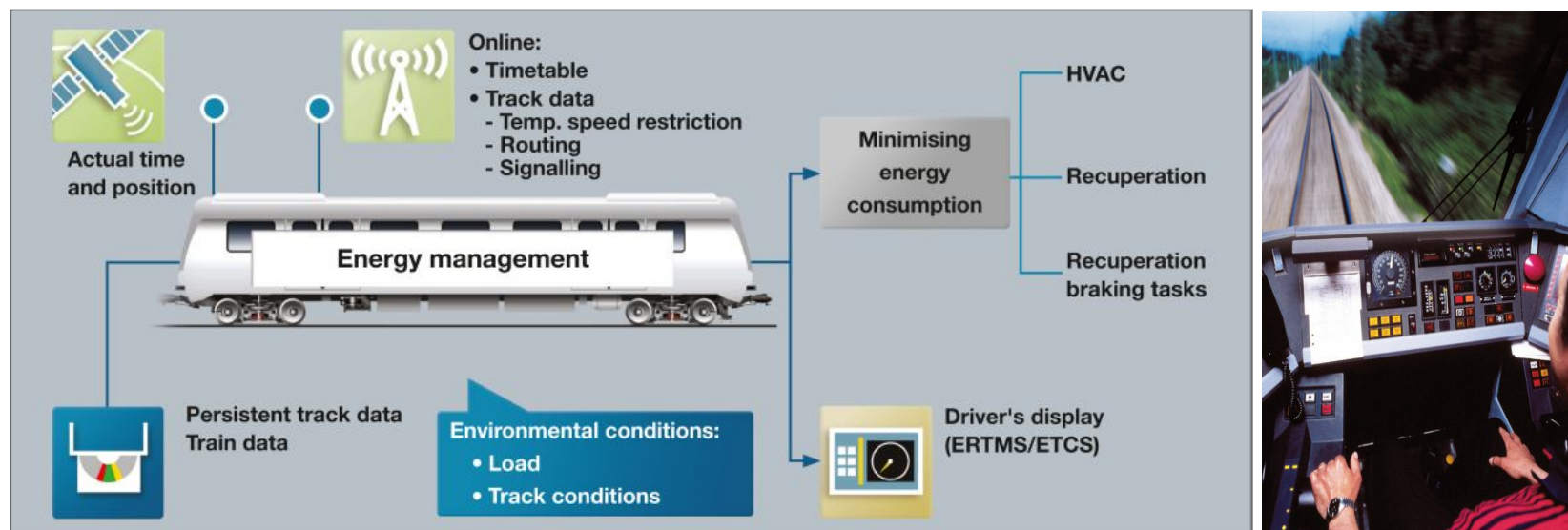
- Capacity to monitor, measure and optimize energy
  - New norm: EN50463
  - New European Billing directive (UIC 930)



© Bombardier Inc. or its subsidiaries. All rights reserved.

# Optimize operations to increase capacity and reduce resource consumption

- **Improve driving behaviour**
  - Driver assistance system and driver training
  - In cab real-time visibility of energy consumption to optimize driving style for low energy operation
- **ATO and Unattended vehicle with energy flow optimization**
  - Optimize the route according the system characteristics



© Bombardier Inc. or its subsidiaries. All rights reserved.

# Thank you for your attention

---

The challenges of our world demand a new formula for economic sustainability

Saving **E**nergy  
Improving **E**fficiency  
Achieving sound **E**conomic value  
Protecting the **E**nvironment



**eco<sup>4</sup>**

The new formula for total train performance from Bombardier Transportation

