

# **Emerging Technologies for new generation EMUs**

**Technology for new generation AC/DC EMUs in Mumbai**



# What is an EMU?

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- It is an **E**lectrical **M**ultiple **U**nit used for main line, urban & suburban Traffic
- High acceleration & deceleration
- Generally fixed formation
- Distributed power concept
- Door width is more for quick exchange of passengers

# The EMUs worldwide – From Suburban trains to solutions for Mainline and Mass transit

**SIEMENS**



## Main line Trains\* - Velaro (High speed)

Long Distance

Distributed Power

Speed 200 ~350 km/h  
>250 km/h – *High Speed*

Moderate No. of  
passengers

Vehicles with high  
compressive strength

## Mainline Regional\*

Suburban Travel

Distributed Power

Speed up to 160 km/h

High number of  
passengers

Vehicles with high  
compressive strength

## Metro Trains

Urban Mass Transit

Distributed Power

High Acceleration  
Speed up to 100 km/h

Very high no. of  
passengers – up to  
15,000-80,000 PPHPD

Light weight vehicles

## Light Rail (LRT)

Urban Mass transit

Distributed Power

High Acceleration  
Speed up to 100 km/h

Moderate no. of  
passengers – up to  
5,000-25,000 PPHPD

Light weight vehicles

## Mono Rail

Point to Point

Distributed Power

High Acceleration  
Speed up to 100  
km/h

Moderate / Low no.  
of passengers – up  
to 5,000-16,000  
PPHPD

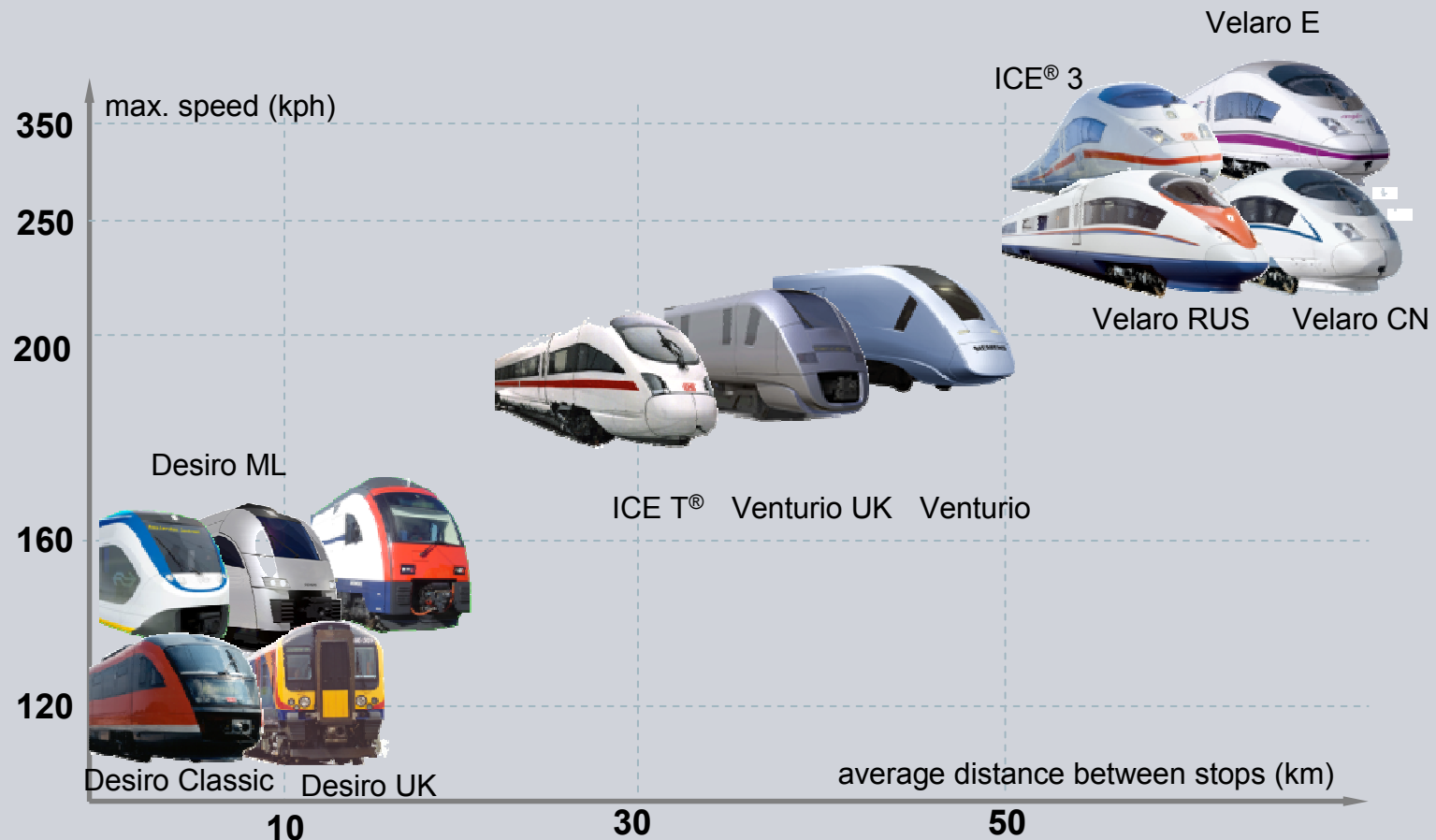
Light weight vehicles

PPHPD – Passenger per hour per direction

\* Includes passenger amenities

# Types of EMUs

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# Types of EMUs

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**DESIRO UK**



**DESIRO Classic, Slovenia**



**DESIRO OSE, Greece**



**DESIRO ET ERL, Malaysia**

# Types of EMUs

**SIEMENS**

**ICE 1**



**ICE 2**



**ICE TD**



**ICE 3**



# Types of EMUs

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**Velaro CN  
China**



**Velaro E  
Spain**



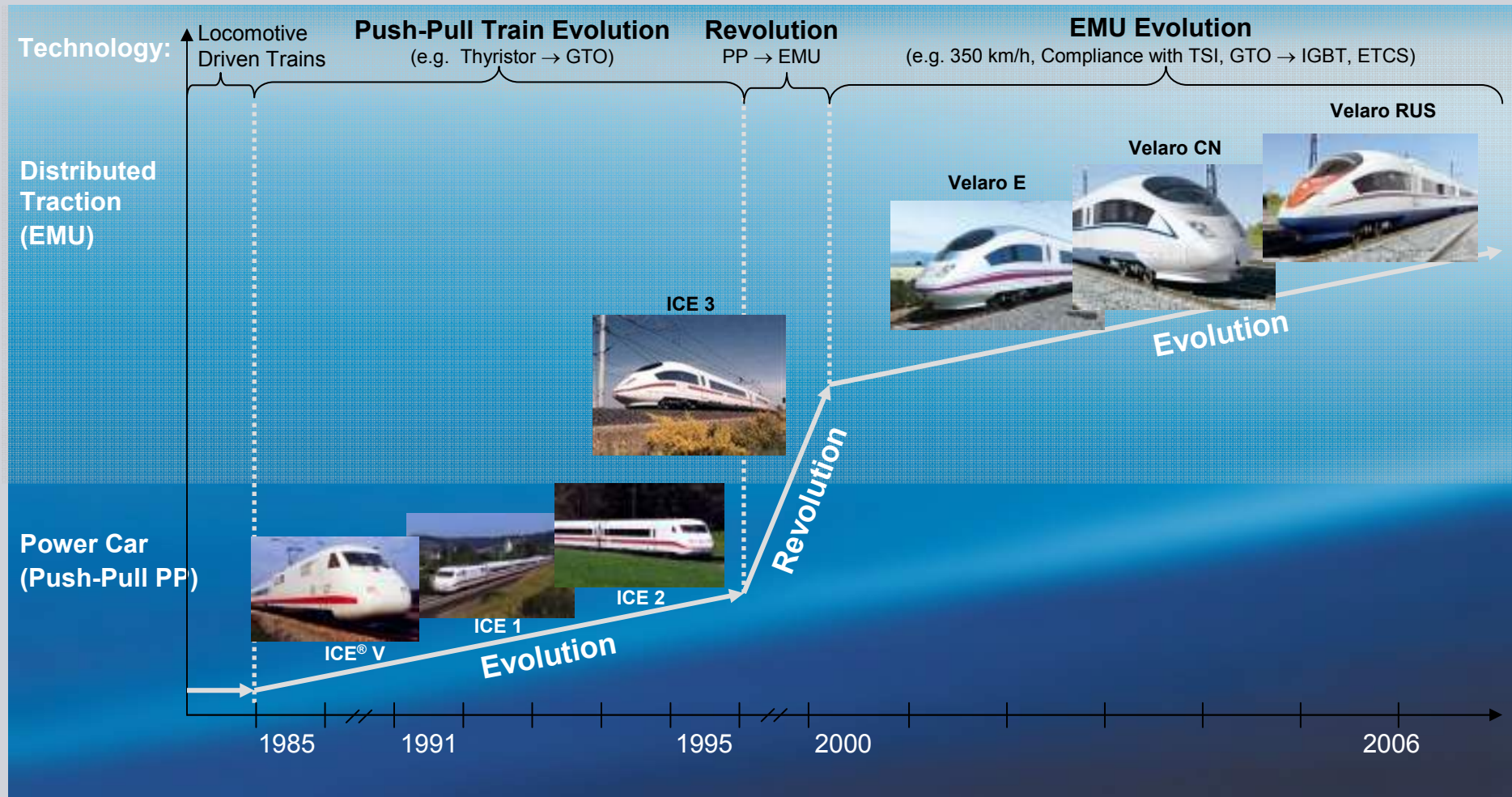
**Velaro RUS  
Russia**





# EMU – a revolution for main line as well

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# Equipment & Sub-systems of an EMU



## **Propulsion Equipment**

- Transformer
- Traction Converter
- Traction Motor
- Micro Processor Control

## **Auxiliary Power Supply Equipment**

- Auxiliary Converter
- Battery
- Battery Charger

## **Roof Equipment**

- Pantograph
- Breaker (VCB or HSCB)
- Lightning Arrestor, CT, PT

## **Train Integrated Management System**

- Central Control Unit
- Compact I/Os, SIBAS KLIPs etc.
- Brake Electronic Control Unit

## **Passenger Information & Cab Equipment**

- Master Controller, Driver's display
- Passenger Information & communication system

## **Carbody**

- Carbody Shell
- Seats, Windows
- Automatic & Semi Automatic Couplers
- Gangways etc.

## **Doors**

- Door Leaves
- Door Drives.

## **Bogie Complete & Brake Equipment**

- Bogie Frame, Wheels & Axles
- Primary & Secondary Suspension etc.
- Parking Brake
- Brake Shoe
- Air Compressor

## **Cab & Saloon Air-Conditioning Equipment**

- Compressor
- Condenser & Evaporator Unit
- Parking Brake
- Ducting & Diffusers

## **Saloon Equipment**

- Lights, fans
- HVAC Unit

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Industry Sector, Mobility Division

# Equipment & Sub-systems of an EMU

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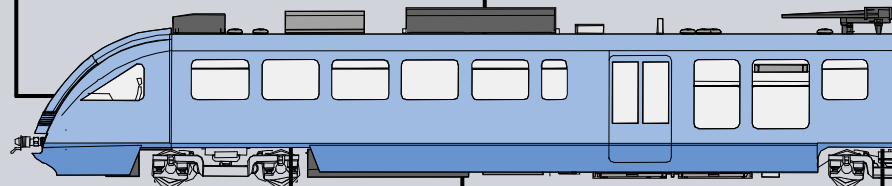
**Couplers,  
driving cab**



**Vehicle body**



**Interiors**



**Bogie**



**Traction converter**



**Control Unit**



**Traction motor**

# Current International Technology of Car Body Material – **SIEMENS** Comparison from Customer's Point of View

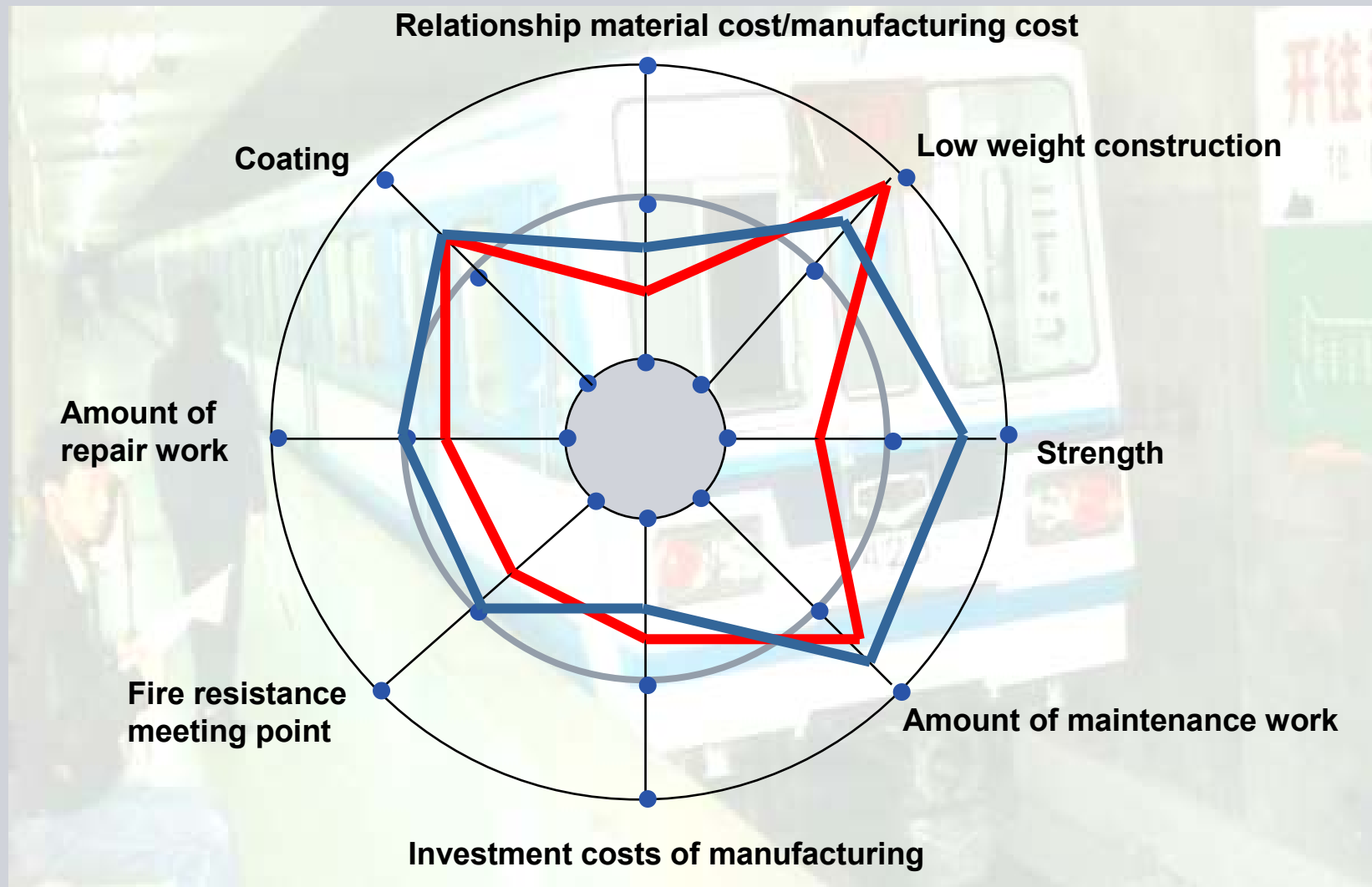
	Steel	Stainless Steel	Aluminium*)
Cost of Material	++	●	-
Labour Cost	+	-	--
Integration of Interfaces for fastening	-	-	+
Weight of Carbody Structure	-	●	+
Corrosion Resistance	-	+	+
Maintenance	+	●	-
Industrial Design/Complex Shapes	-	-	+
Surface Coating/Painting	-	+	●
Fire Resistance w/o additional Insulation	+	+	-
Heat Insulation	+	+	-

**\*) Large Extrusions**

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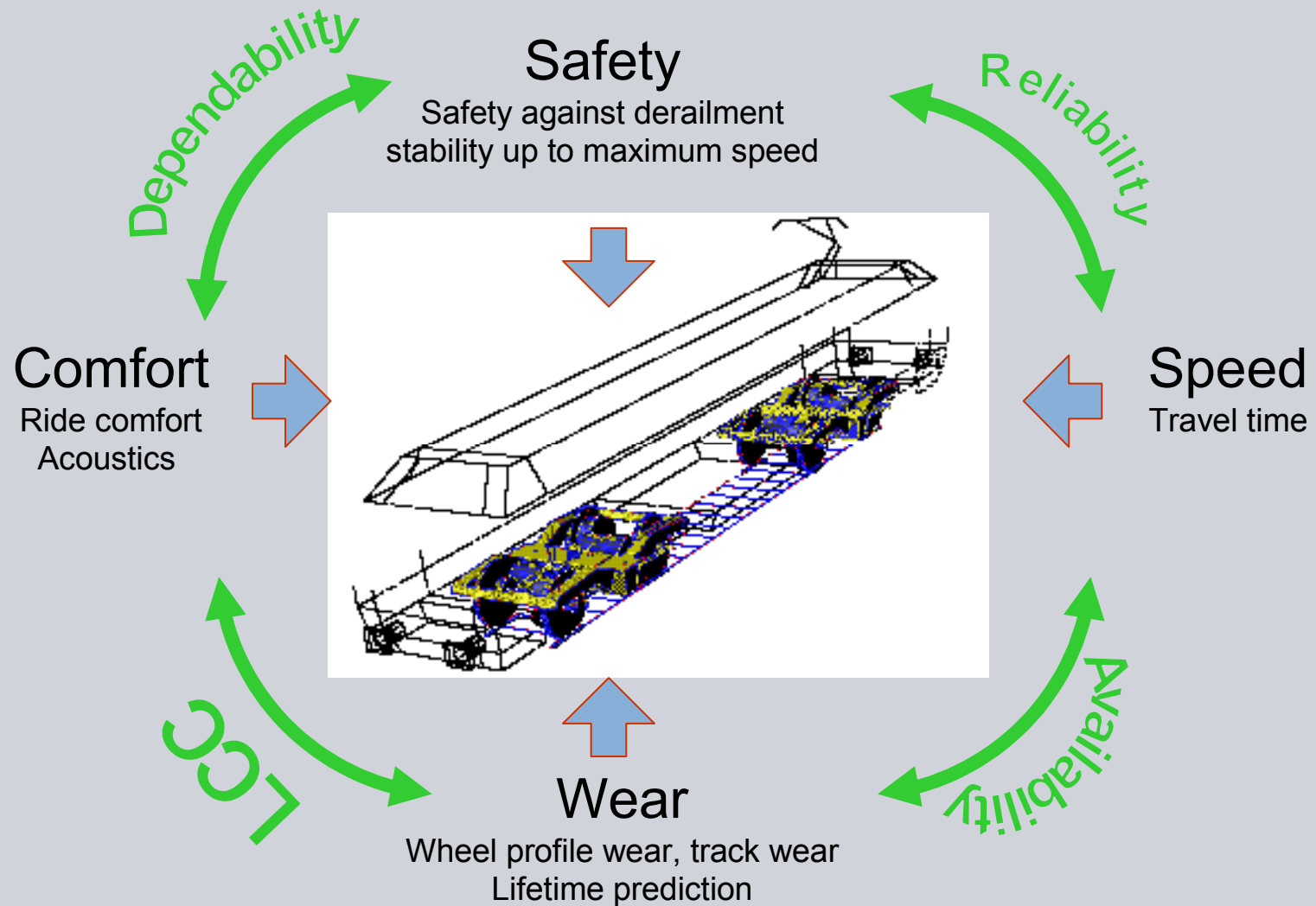


# Current International Technology of Car Body Material – **SIEMENS** Comparison **Stainless Steel**, **Aluminium**



# Current International Technology of Bogies – Bogie – Key Decision factor of operators

SIEMENS



# Current International Technology of Bogies – Bogie – Cost in operation

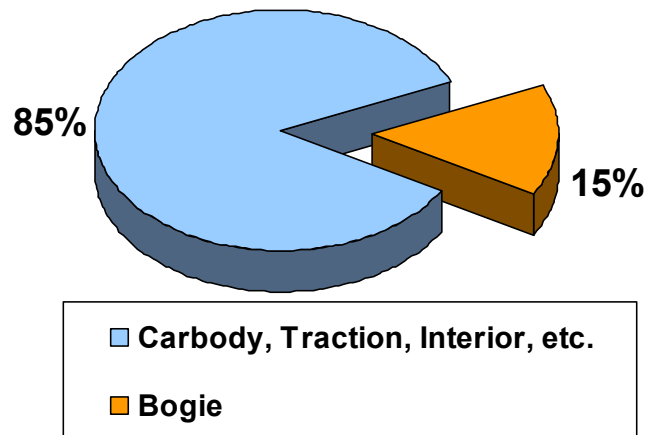
SIEMENS

low portion of  
original equipment

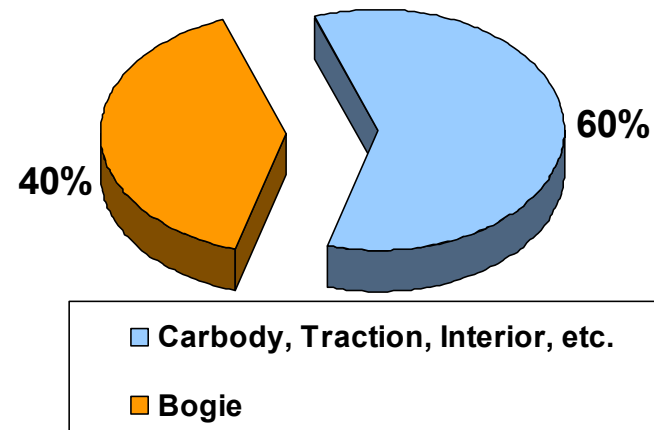
OPERATOR

high portion in total  
cost of operation

Bogies account for 15 % of  
railway vehicle value !



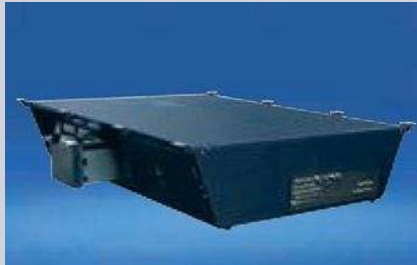
Roughly 40 % of LCC Costs of  
railway vehicles are caused by  
Bogies !



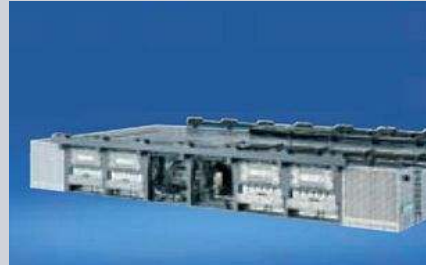


# Current International Technology – Electrical components

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Auxiliary converter



Sibac traction converter



Sibas 32



Traction Motor 1TB2016

- IGBT Based Traction Converter and Auxiliary Converter
- Microprocessor based traction, braking and train control system (sensor less operation, no speed or temperature sensor)
- Regenerative braking for energy recovery
- Extensive diagnostic memory for failure analysis
- State-of-the-art microprocessor based Train Management Systems
- Self ventilated 3 phase asynchronous traction motors
- Extensive audio visual Passenger Information systems
- HVAC Units

# Siemens Contribution in EMUs – Development and evolution in recent years

**SIEMENS**

**Experience  
+ Innovation  
= Desiro ML Vehicle Platform**

Siemens as  
supplier for traction;  
traction with GTOs



CP 2300 / 2400  
Portugal

Siemens builds  
partially under licence;  
traction with GTOs



Desiro ET  
Malaysia

Full Siemens vehicle;  
traction with high voltage GTOs



Desiro EMG 312  
Slovenia

Full Siemens vehicle;  
traction with IGBTs



Desiro OSE  
Greece



**Desiro  
ML  
Platform**

- various types of traction:  
Diesel or electrical
- various train configurations:  
2 to 4 cars
- various entrance heights:  
600, 800, 1000 mm

## Mumbai EMUs – Current Stock with DC technology

**SIEMENS**



### Brief Details of Network

Length – Route km over 302  
Number of stations – More than 100  
3 lines – Western, Central & Harbour  
Caters to 6.1 Mio commuters every day  
Only network in India with 1.5 kV DC  
(conversion to 25kV in progress)  
Number of trains – 2200 (approx.)

### Brief Details of existing DC Stock

9 car rakes – 200 (approx.)

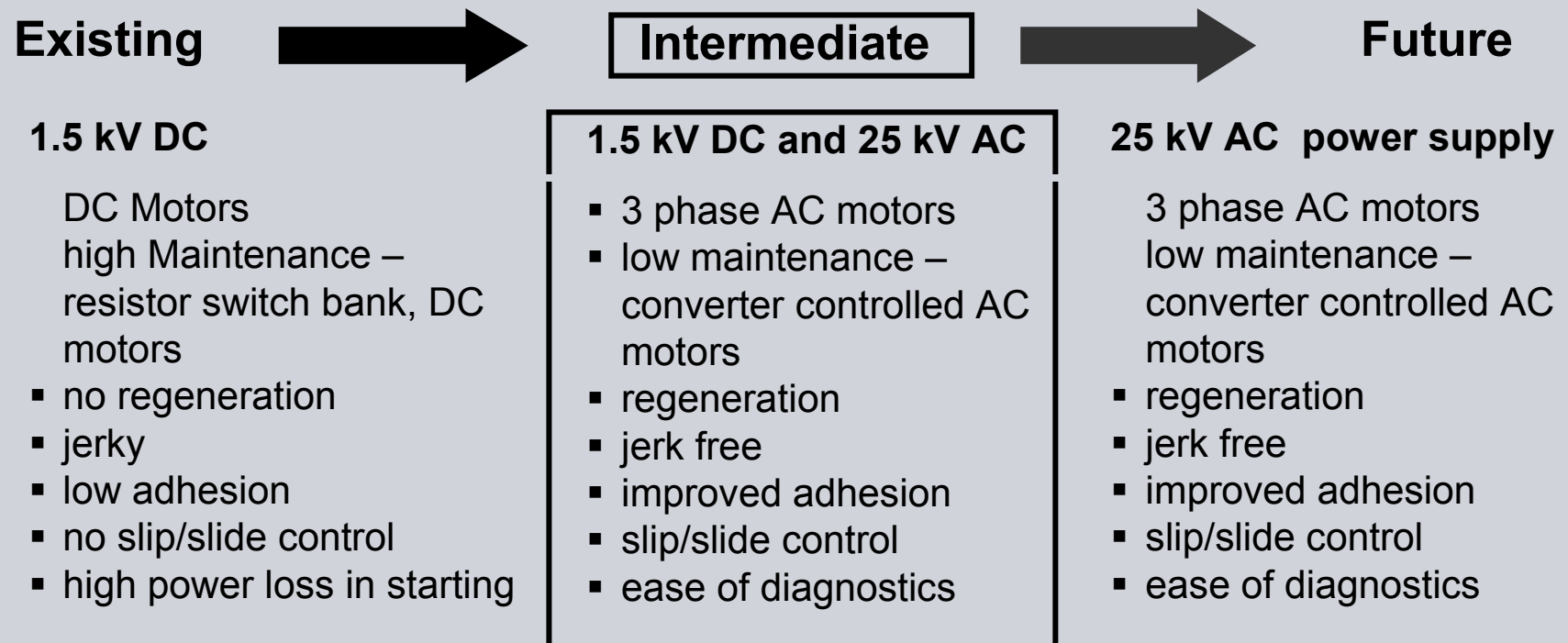


## Mumbai EMUs – Need for AC/DC EMUs

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**Conversion from 1.5 kV DC to 25 kV AC system voltage**

**Changeover from DC traction to AC traction technology**



# EMU Mumbai – Scope of supply – Major items



## **Propulsion Equipment**

- Transformer
- Traction Converter
- Traction Motor
- Micro Processor Control

## **Auxiliary Power Supply Equipment**

- Auxiliary Converter
- Battery Charger

## **Roof Equipment**

- Pantograph
- Breaker (VCB & HSCB)
- Lightning Arrestor,
- Current Transformer
- Voltage transformer
- Brake resistor
- AC DC changeover switch

## **Train Integrated Management System**

- Central Control Unit (CCU)
- SIBAS KLIPs etc.
- Brake Electronic Control Unit (BECU)

## **Brake Equipment**

- Parking brake
- Air Compressor
- Main compressor, air dryer, air filter

## **Cab & Saloon Air-Conditioning Equipment**

- Ventilation system (only in MRVC)

## **Saloon Equipment**

- Lights
- Fans

## **Passenger Information & Cab Equipment**

- Master Controller, Driver's display
- Passenger Information & communication system
- Driver's desk, Head light, tail light

## **Cables & accessories**

- Power cables
- Control cables
- Intervehicle jumpers & couplers

## **Fire detection and extinguishing system**

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# Mumbai EMUs – Solution by Siemens – Entire Propulsion and Electrical Package

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Transformers



Auxiliary converter



Traction motors



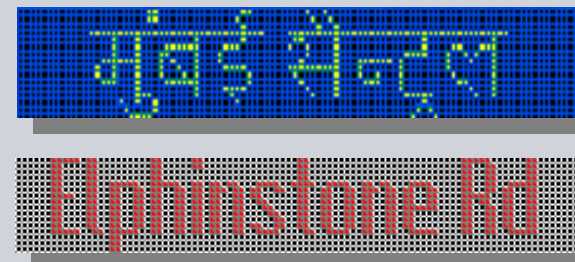
Traction Converter



Driver Desk



Roof Equipment



Passenger Information System

(Example pictures)

## EMU Mumbai – Critical Requirements of Order



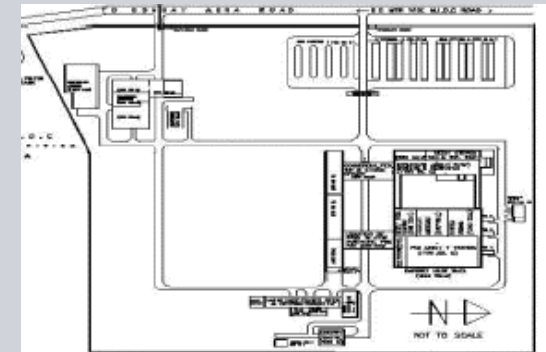
- Design to consider super dense crush load of 16 people/m<sup>2</sup>
- Equipments to withstand humid and salty environment with excessive vibrations
- Flood proofing of underslung equipment up to 760 mm of height above rail level.
- Design to consider 25% choking of air filters and radiator fins.
- Introduction of fresh air in cars to minimise Carbon-dioxide levels
- Regeneration of approx 30% energy
- Reduced specific energy consumption

Siemens fulfils all these requirements

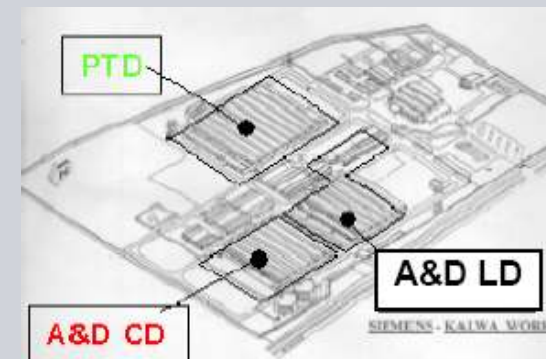
## Siemens Local presence in India – For EMUs

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**Nashik:**  
**Local Engineering**  
**and Manufacturing**  
**of Traction Converters**  
**and Auxiliary Converters**



**Kalwa:**  
**Local Engineering**  
**and Manufacturing**  
**of Traction Motors**



**Local Service Support for Maintaining the fleet**



# Mumbai EMUs – Technical data

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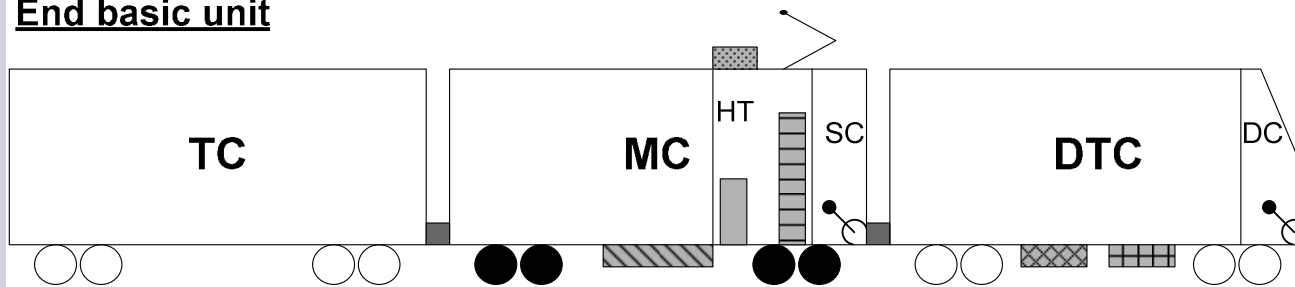
## Technical Data

Year	2005 – 2010			
Number of cars	9	12	15	18
Power system	AC 25/50 + DC 1.5 kV/Hz			
Maximum power at wheel	3300	4400	5500	6600 kW
Maximum speed	100	←	←	← kmph
Weight	630	840	1050	1260 t
Track gauge	1676	←	←	← mm
Seats	900	1200	1500	1800
Numbers to be built	170 + 303 (3-car units)			

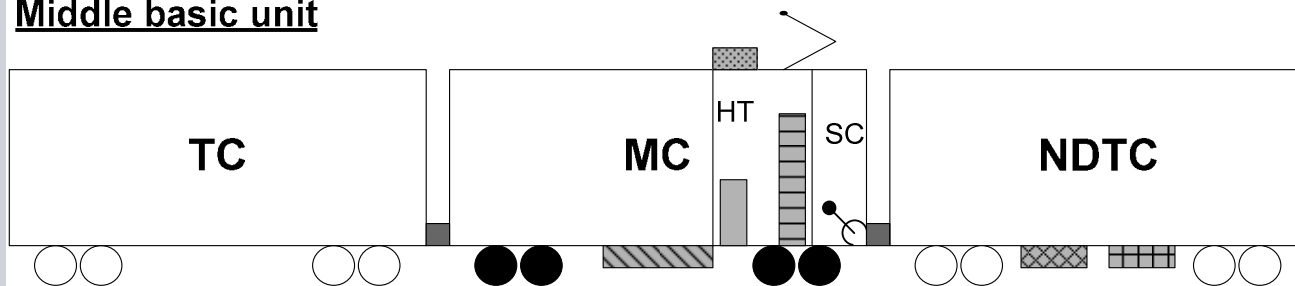
# EMU Mumbai – Train Disposition

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## End basic unit



## Middle basic unit

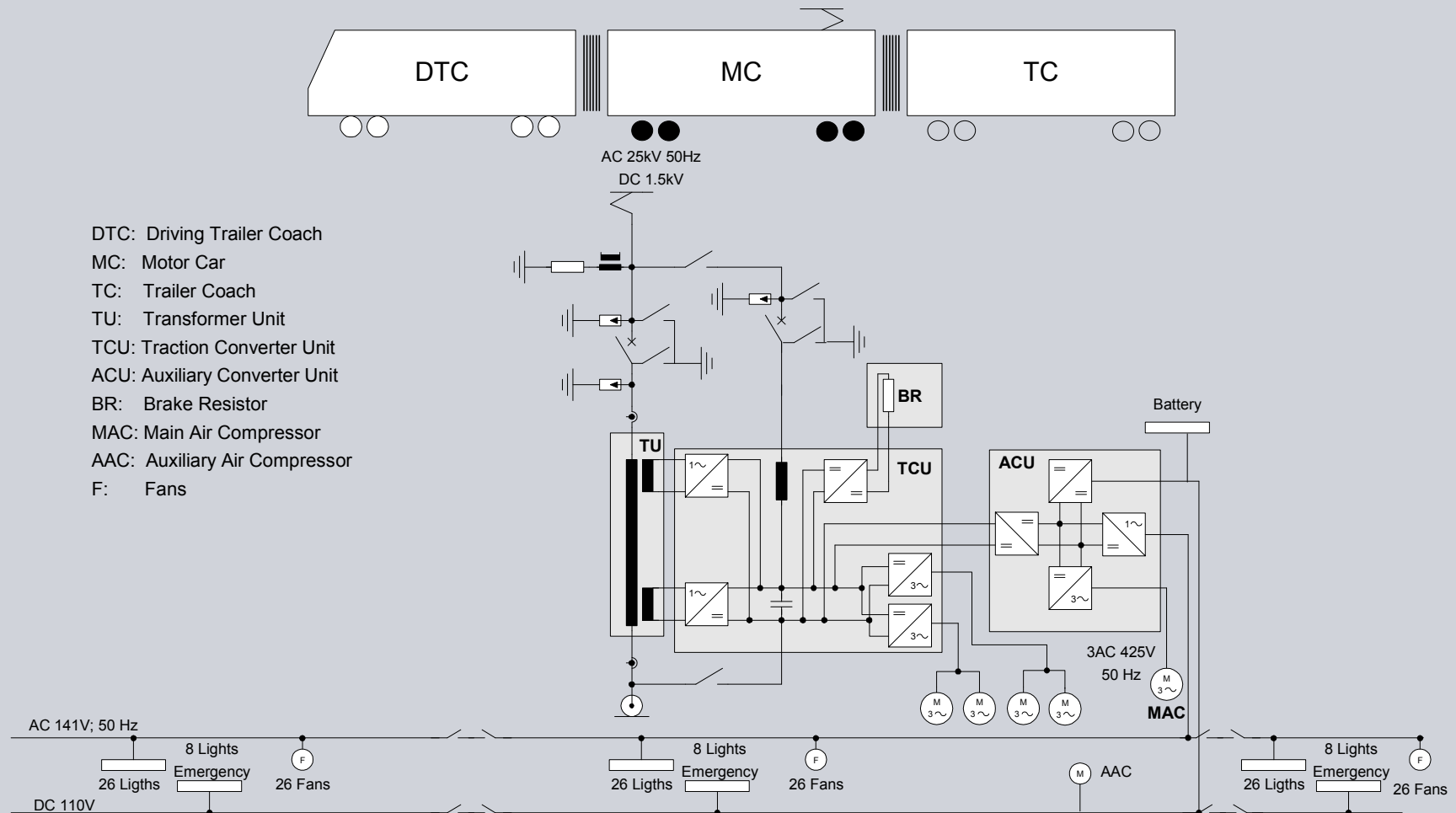


### Legend:

- DTC Driving Trailer Car
- NDTC Non Driving Trailer Car
- MC Motor Car
- TC Trailer Car
- HT High Tension Comp.
- DC Driving Cab
- SC Shunting Cab
- Power axle
- Trailer axle
- ▨ Transformer
- ▤ Brake resistor
- ▥ Traction converter
- ▦ Auxillary converter
- ⚙ Master controller
- ⚡ Pantograph
- ▧ Main air compressor
- ▩ Battery (110V DC)

# Mumbai EMUs – Principal Circuit Diagram

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## Mumbai EMUs – Most Important Features



- Dual Voltage operation
- Force air cooled IGBT based Traction converter and Auxiliary converter.
- Improvement in passenger comfort by ventilation units.
- Low energy consumption and low life cycle costs.
- High reliability and service friendly.
- Self-ventilated three-phase asynchronous traction motors, low maintenance.
- Train and traction control system by microprocessor based Sibas® 32.
- Bus system and train communication network (TCN).
- Passenger information system.
- Up to 15 / 18 car formation.
- Load sensing to adjust braking.
- Fire detection and extinguishing system.
- Extensive diagnostic memory.
- Improved illumination for better visibility inside vehicles
- Ergonomic driver's desk

## Mumbai EMUs – Current Status



- 3 Trains in passenger service in Western Railway
- 11 Trains in passenger service in Central Railway
- Production of series trains in progress at ICF



## Installation at ICF

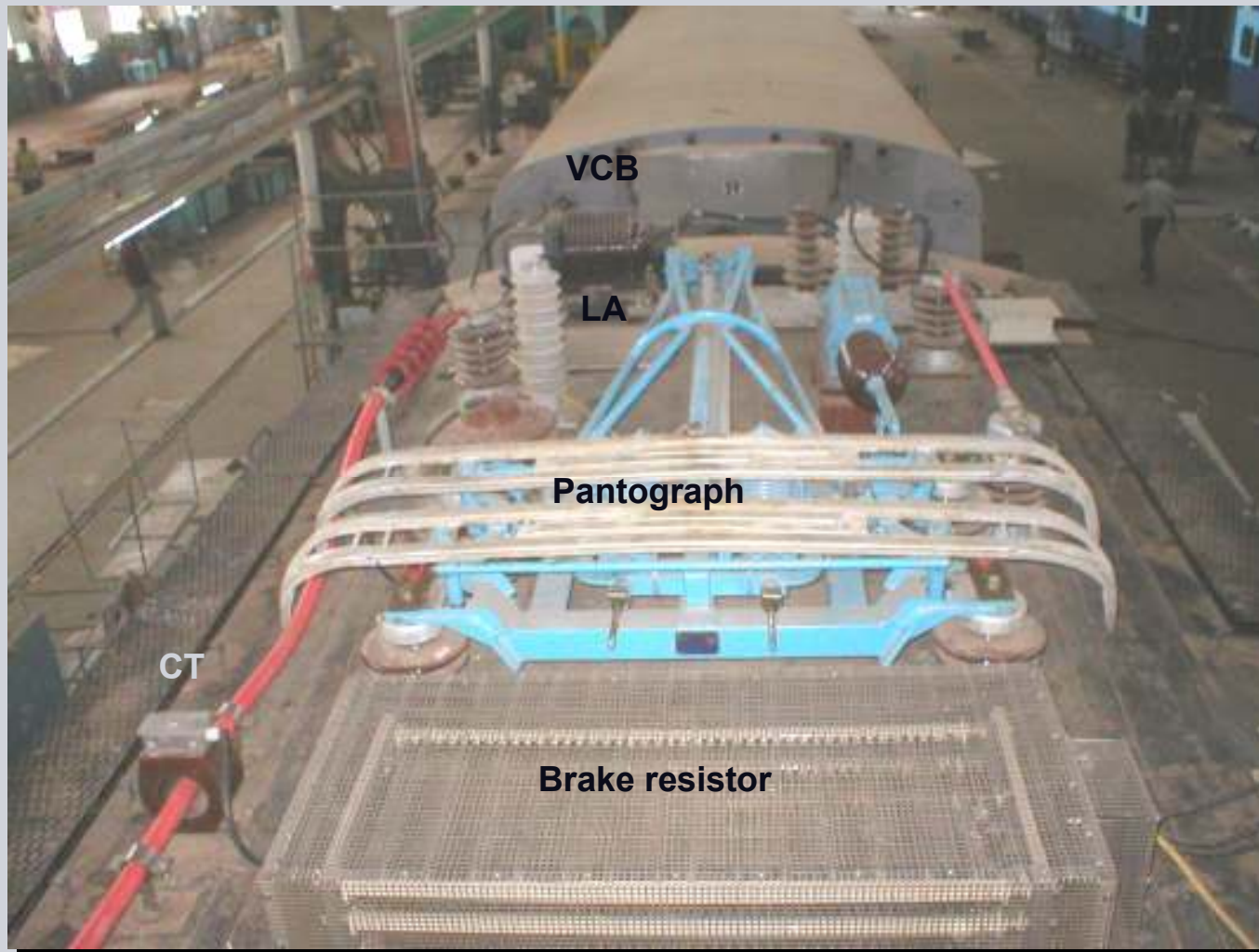
**SIEMENS**



**Car body – Driving Trailer Car (DTC)**



**Car interiors – Ventilation system, fans, lights**



**Motor coach - Roof**



## Installation at ICF

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**Motor coach – HT compartment**

September 2008

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Industry Sector, Mobility Division

## Installation at ICF

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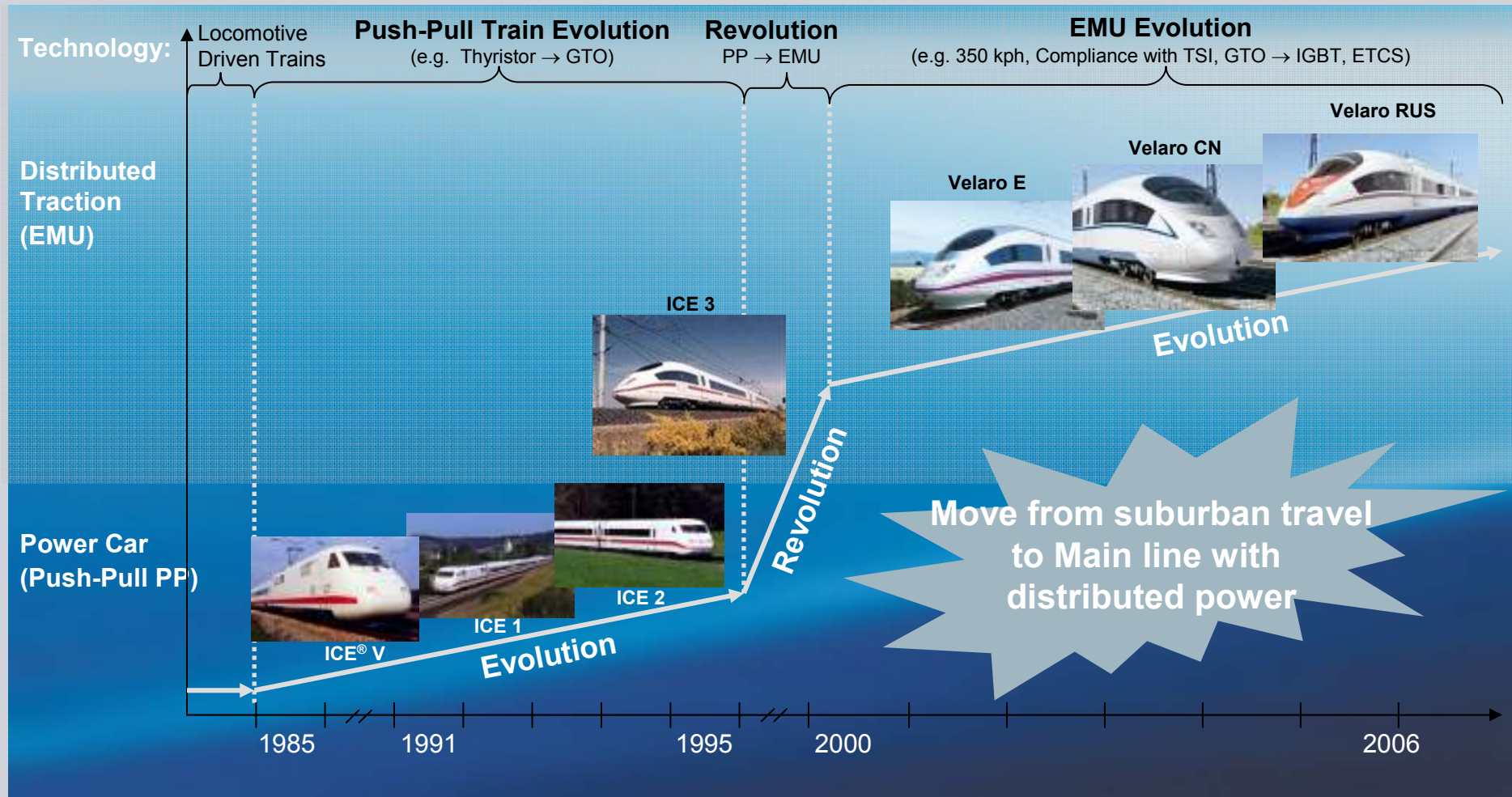


**Complete train**



# EMU – a revolution for main line as well

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**Thank You for your attention**

