

CRRC Nanjing Puzhen Co., Ltd.

CONTENT



Company Profile



Integrated Solution and Services



New Products

Part I Company Profile

Mission

Connecting the world through better mobility



Green



Value



Govern



Undertaking

- A high-quality product portfolio to help achieve global ESG goals

Part I Company Profile

CRRC Group



170,000+

CRRC Group Employees



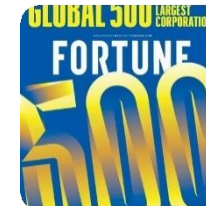
46

Subsidiaries



37

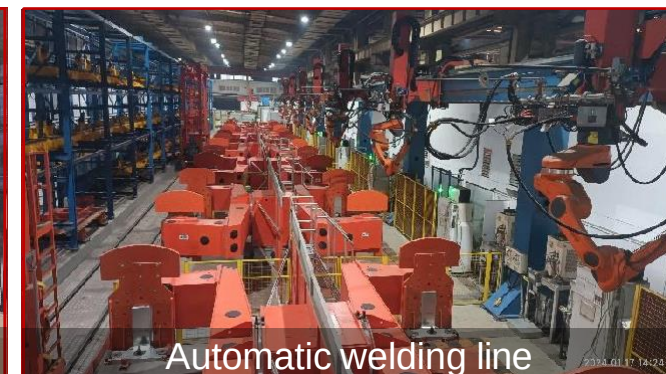
billion USD Revenue
in 2022



385

Ranking at Fortune
Global 500 List, 2022

- Employees 10000+
- Annual capacity: 2,000+ passenger coaches and EMUs
- 2,500 metro vehicles
- 550 medium and low capacity vehicles



Part I Company Profile

Full Range of Railway Products



Passenger coach and EMU



Metro

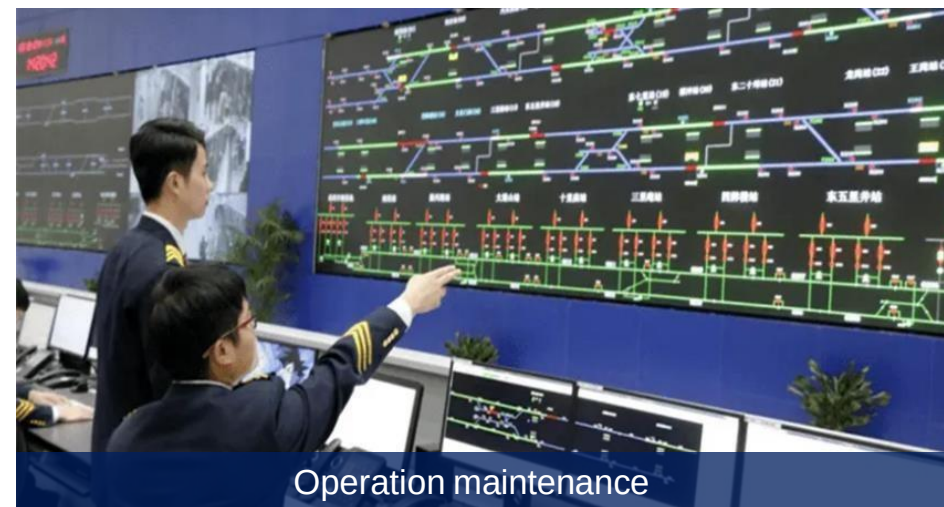
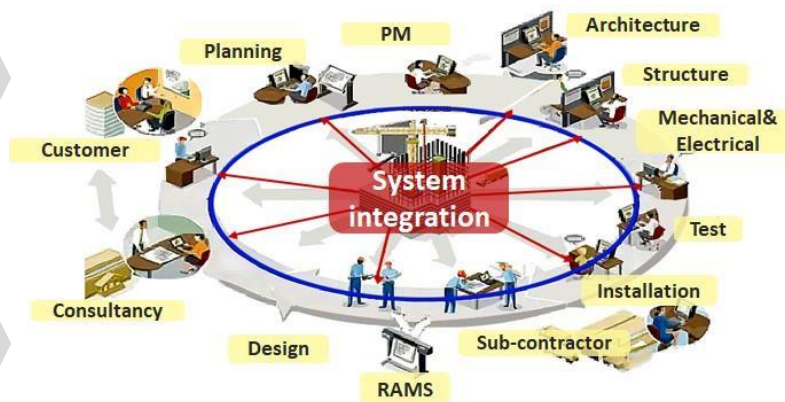


Medium and low capacity platform

Turnkey Solution

- EPC/BOT/PPP system integration package

- Operation maintenance and overhaul services



Operation maintenance

R&D of Digital-rail Rapid Transit

Digital-rail Rapid Transit, or DRT, is a reliable mass transit system that operates on virtue digital tracks. Based on magnetic signals and supplemented by optical detection, satellite positioning, and inertial navigation correction technologies, virtue tracks of DRT function similarly as physical tracks, including bearing, guiding and restraining. By navigation information along the routes, DRT system realizes autonomous driving.

Advantages as a rail transit system



- ❑ Reliable solutions and interfaces
- ❑ Dedicated tracks
- ❑ Energy efficient, environmental friendly
- ❑ ATP/ATO



Advantages as a ground transit system



- ❑ Low construction cost
- ❑ Flexible route design
- ❑ Flexible stop arrangement



Technology innovation



- ❑ Virtue digital tracks
- ❑ Integrated navigation technologies onboard
- ❑ New technologies materials



Customer demands



- ❑ Geographical cultures
- ❑ Operation conditions, safety, and, cost
- ❑ System construction cost



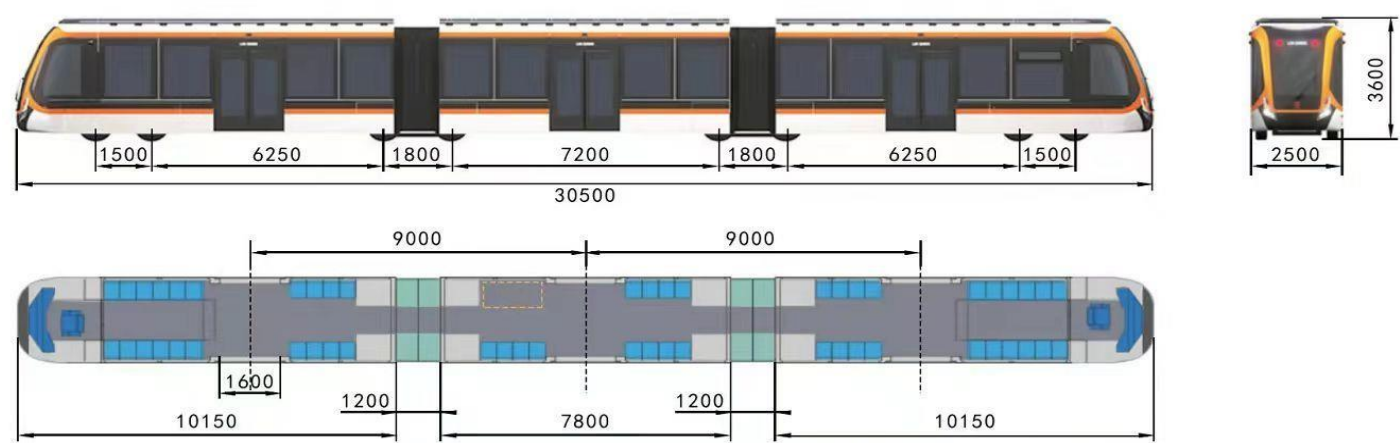
DRT



- ❑ Smart rail transit system
- ❑ Low floor design, and intelligent navigation

Part III DRT Solution

Rated Capacity 6/m2 , headway 1.5~3 mins, operation Speed is 18~25km/h :



Formation	2 car	3 car	4 car
Length/m	21.5	30.5	39.5
Seating Capacity/Person (Flexible adjustment)	40	56	72
Rated Passenger Capacity/4 Person	120	179	248
Rated Passenger Capacity/6 Person	162	241	332
Overloaded Passenger Capacity/ 8 Person	202	302	416

Passenger Capacity :

- ✓ 3-car configuration;
- ✓ Rated Capacity 6/m2
- ✓ Headway is 2.5 mins,
- ✓ Total capacity per direction per hour: 5784

Passenger Capacity

- ✓ 4-car configuration;
- ✓ Rated Capacity 6/m2
- ✓ Headway is 2.5 mins,
- ✓ Total capacity per direction per hour: :7968.

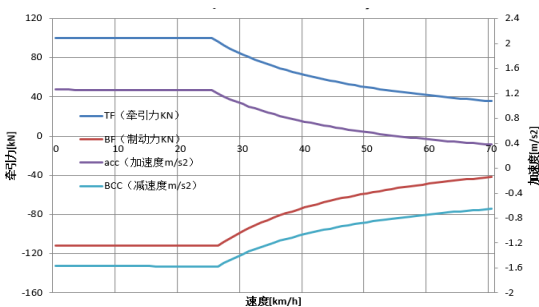
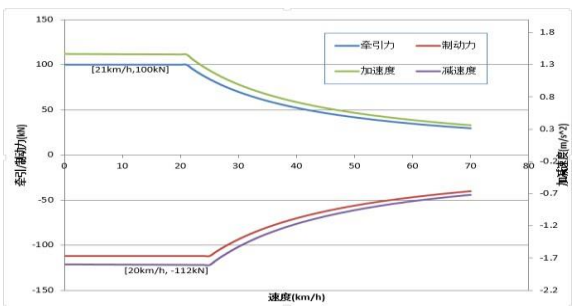
Part III DRT Solution

Rolling Stock



- ✓ Design Speed 80km/h
- ✓ Average Acceleration (0-40km/h) $\geq 1.0\text{m/s}^2$
- ✓ Average Acceleration (0-70km/h) $\geq 0.7\text{m/s}^2$
- ✓ Average deceleration of service braking $\geq 1.1\text{m/s}^2$
- ✓ Average deceleration of safe braking $\geq 1.0\text{m/s}^2$

- ✓ Min lane width : 3.3m
- ✓ Max axle load : 7.5t
- ✓ Min turning radius : 15m
- ✓ Climbing performance : 150‰
- ✓ Power supply: Supercapacitor/hydrogen
- ✓ Capacity(6person/m2): 241
- ✓ Length (3 modules): 30.5
- ✓ Maximum width: 2.5m
- ✓ Maximum Height: 3.6m
- ✓ Floor Height: 320mm

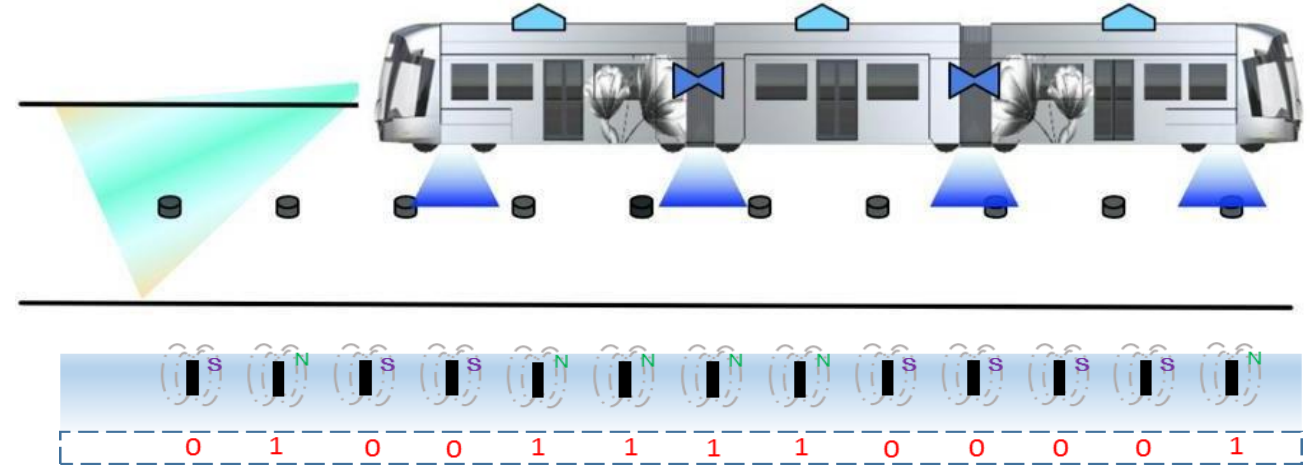
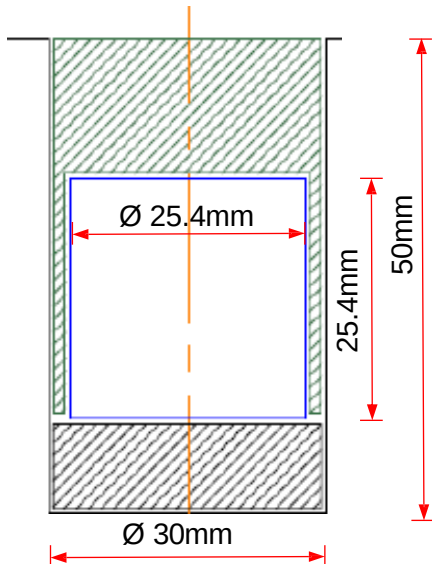


Part III DRT Solution

Road & Magnetic Nail

Magnetic Nail

- ✓ Material: Permanent magnetic ferrite
- ✓ Installation interval 1m
- ✓ Size: Diameter is 25.4mm
Height is 25.4mm
- ✓ Installation hole: Diameter is 30mm
Height is 50mm, fill with glue
- ✓ Temperature : $-60^{\circ}\text{C}\sim 180^{\circ}\text{C}$

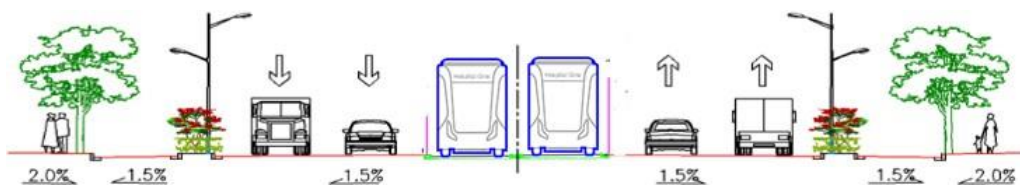


The magnetic nail is a reference unit for vehicle positioning, which is embedded in the road to **measure the position of the vehicle**, and the lateral deviation of the vehicle body and the road centerline can be determined, so as to control the movement of the vehicle in the direction of reducing the deviation to achieve the **guidance function**. In addition to the tracking and guidance function, the digital track also provides functions such as **full positioning, safety protection, digital map, and electronic turnout**.

Part III DRT Solution

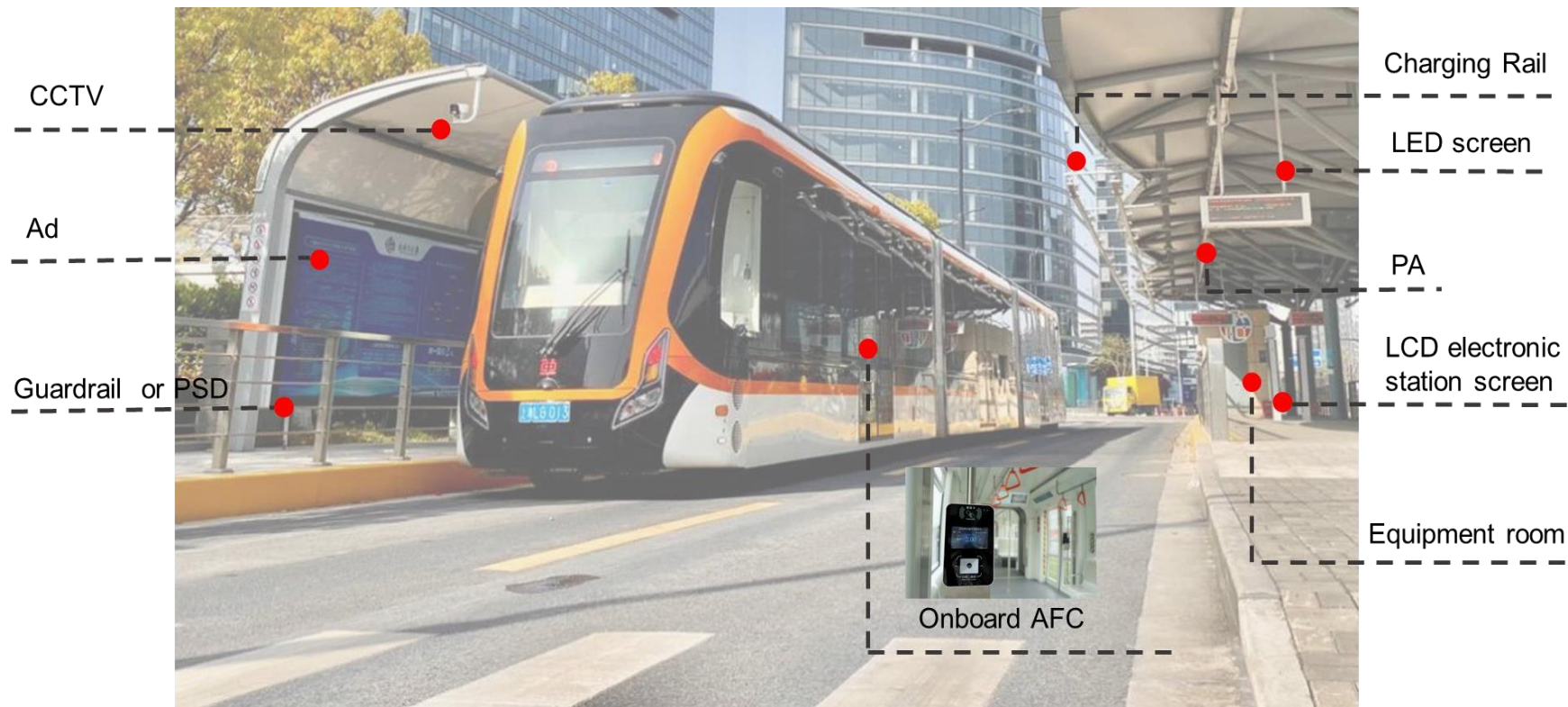
Station

◆ DRT runs in the middle of the road (Island Station)



◆ Besides the city road (Side Station)

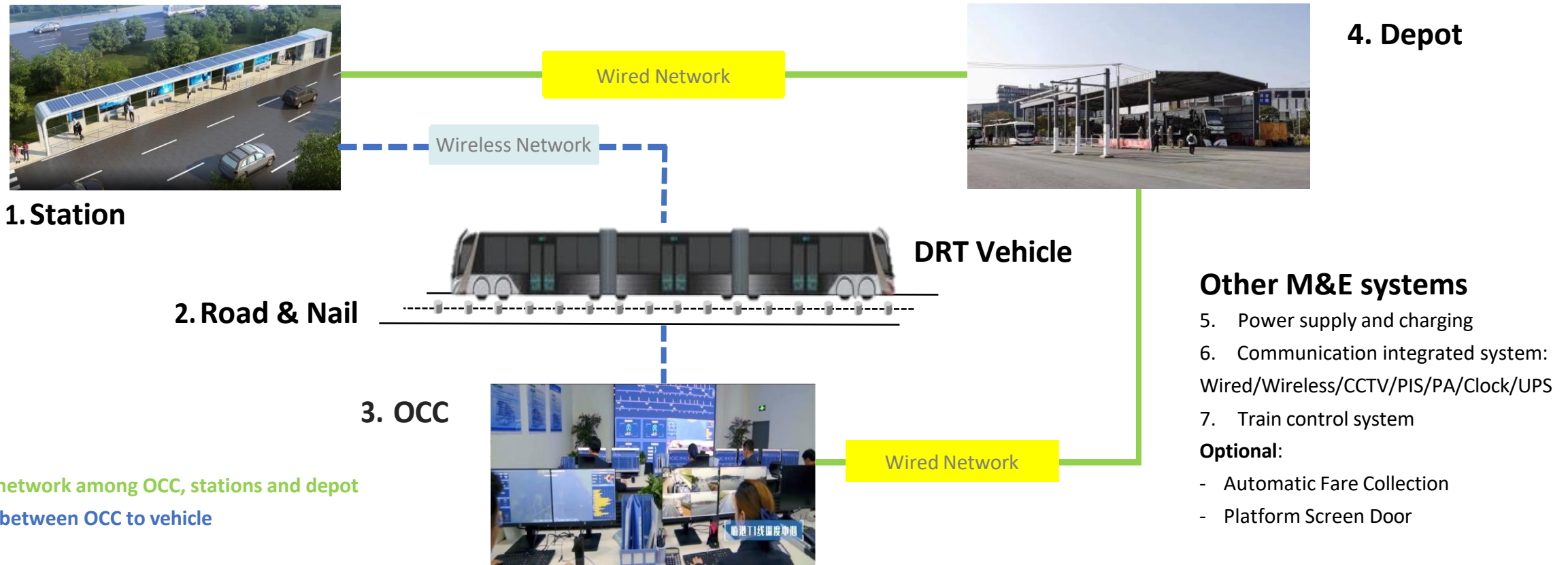




- | | | | |
|-------------------------|--------|----------------------------------|---------------------------|
| ✓ Platform Height: | 280mm | ✓ Gap between station to trains: | ≤150mm |
| ✓ Island Station Width: | ≥ 1.5m | ✓ Station Area Road Width: | ≥3.5m |
| ✓ Side Station Width: | ≥ 3m | ✓ Equipment Room Space around: | 1.5m*3.1m≈5m ² |

DRT Turnkey Solution

With **rolling stock design & production** and **system integration** as core competitiveness, **DRT turnkey solution** can be provided from consultancy, investment and financing, design, rolling stock manufacture, E&M equipment supply and installation, test & commissioning to operation & maintenance



◆ **Wired network among OCC, stations and depot**

◆ **4G/5G between OCC to vehicle**

Part III DRT Solution

Road & Magnetic Nail

1. Road Requirement

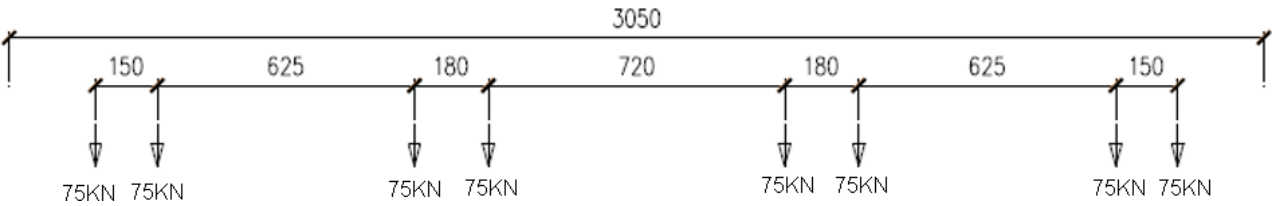
- ✓ Trunk road. The design resilience modulus value of the top surface of the roadbed $\geq 40\text{MPa}$
- ✓ Branch road. The design resilience modulus value of the top surface of the roadbed $\geq 35\text{MPa}$

2. Pavement Structure

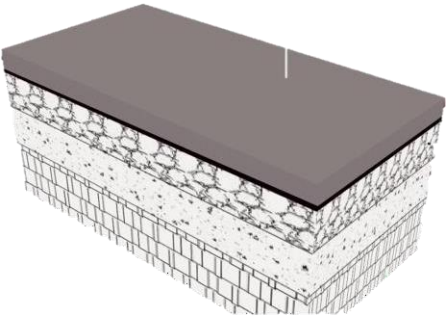
- ✓ Cement Concrete Road (preferred)
- ✓ Asphalt road surface

3. Load Requirement

- ✓ 7.5 t Ref. Trunk road defined by standard CJJ37 or similar standards



数轨（DRT）列车荷载计算图示（单位：cm，kN）



26cm C35 Cement concrete	26cm C35水泥混凝土
20cm C30 Cement concrete (Double steel mesh)	20cm C30水泥混凝土 (双层钢筋网片)
15cm Gravel sand	15cm 砾石砂
Raw soil crushing	原土碾压
Cement paste	水泥净浆
Original surface layer	原面层
Original base layer	原基层
Original base	原底基层

Part III DRT Solution

Road & Magnetic Nail

Digital track virtual guidance technology

- ✓ Magnetic nail + optical + satellite
- ✓ All wheels coordinated steering

Tracking and guiding

Virtual turnout

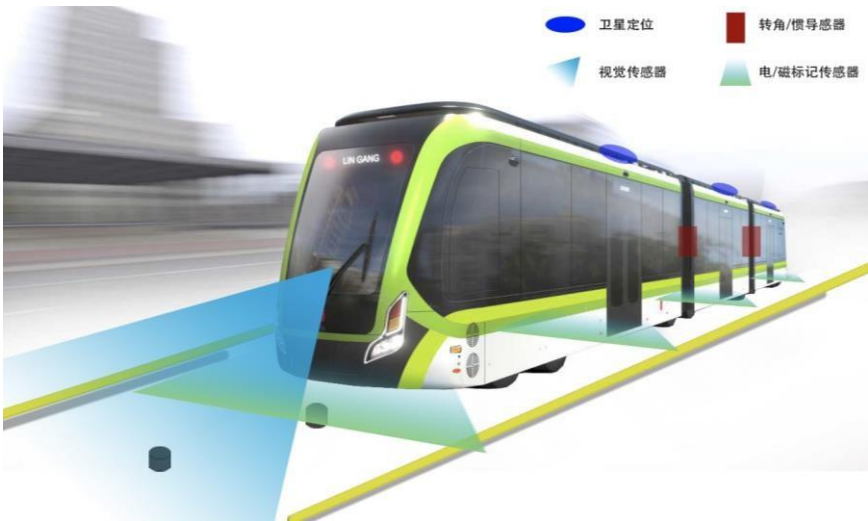
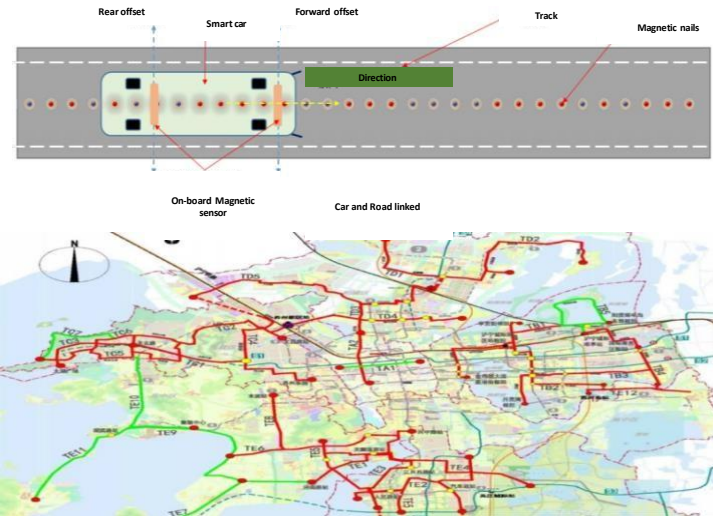
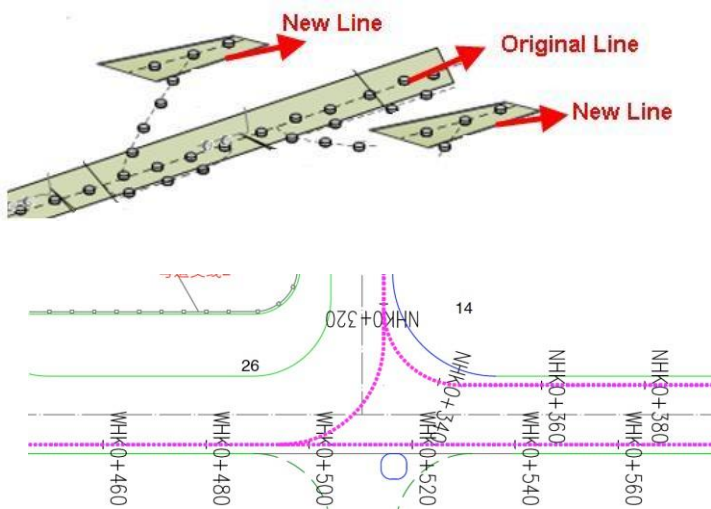
Positioning and control

Real time detection

Digital Map

Safety protection

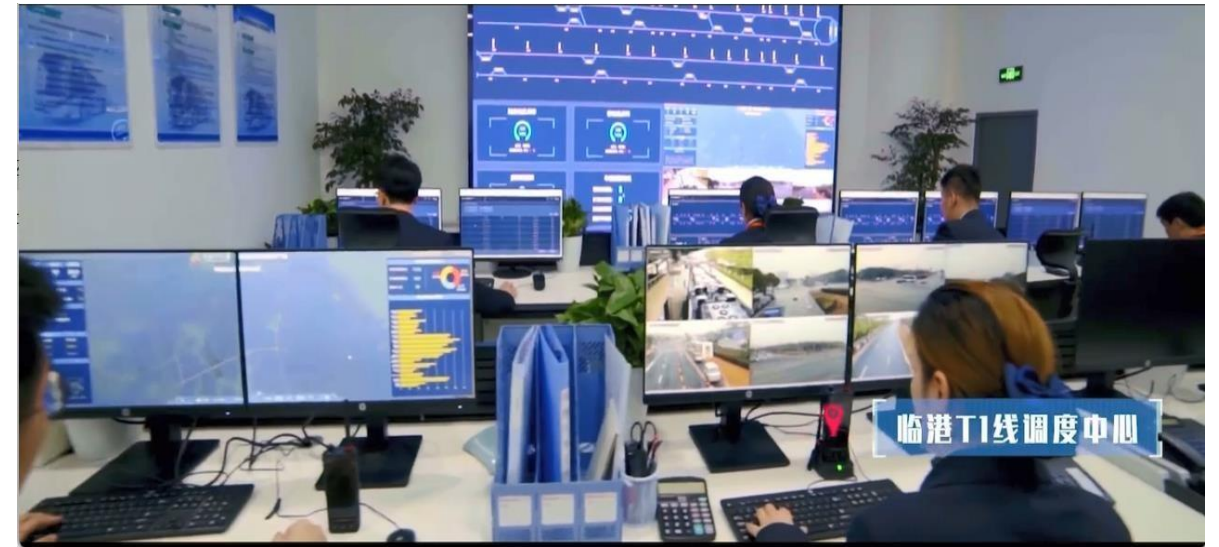
Autonomous driving level :GOA2 level or L3 level



Part III DRT Solution

OCC

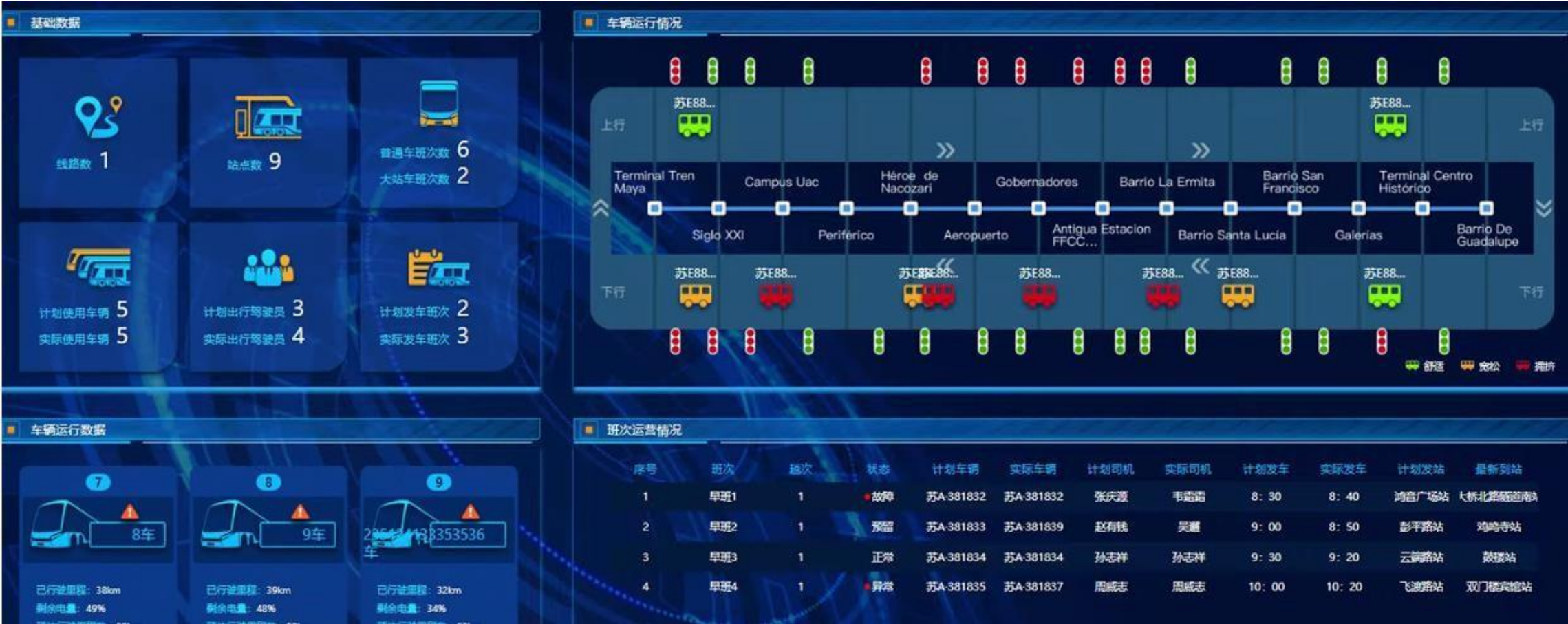
- ❑ Operation Control Center :
- ✓ Include integrated display screen and personnel working station, the spare is around 90m².



Part III DRT Solution

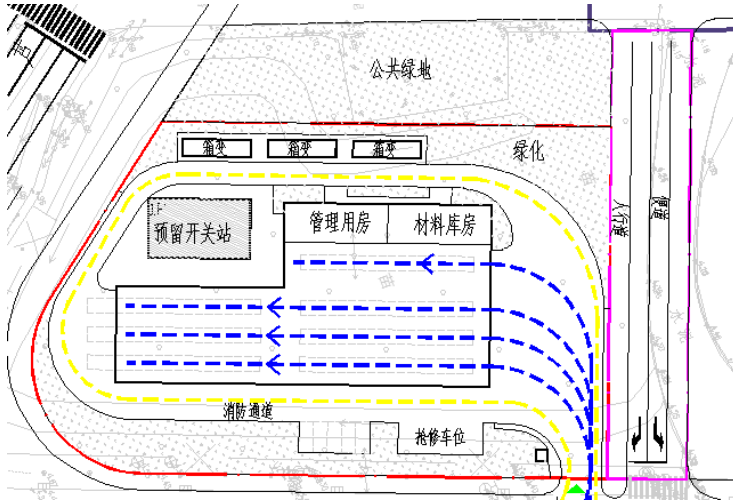
Train control system

The train operation control system is composed of automatic scheduling and vehicle monitoring system, with functions such as operation scheduling, driving monitoring, and fault monitoring



Part III DRT Solution

Depot



Main area:

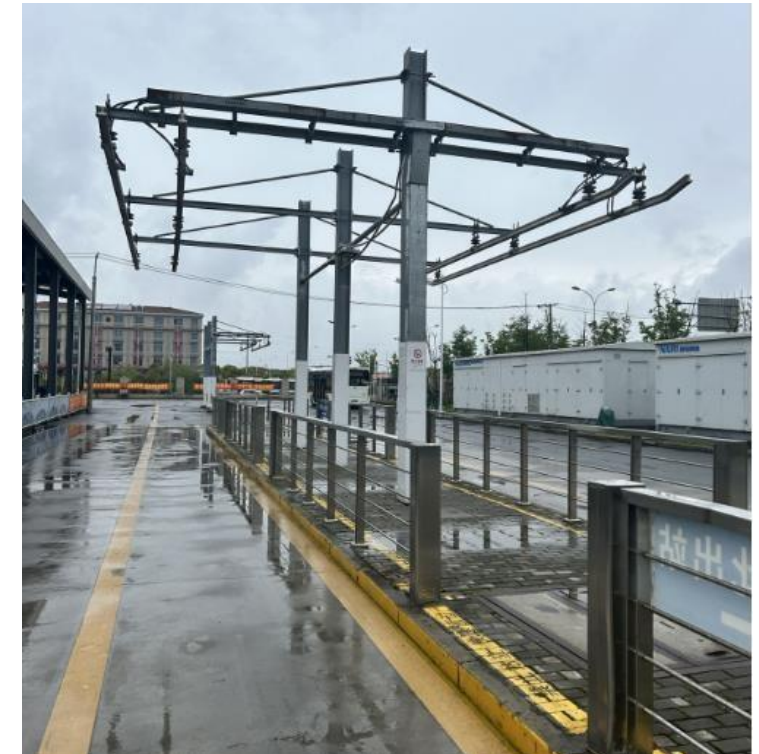
- ✓ Parking area
- ✓ Routine Maintenance
- ✓ Corrective Maintenance
- ✓ Charging station
- ✓ Electrical substation
- ✓ Spare parts storage

Electrical Substation Space

- Size: 3.2*16.2m
- Land area : 5.2*18m
- Construction height: 1.65m
- Capacity: 750V*1000A*2 sets

Main Equipment:

- ✓ Mobile lifting machines
- ✓ vehicle washing equipment
- vacuum cleaners
- ✓ tire dismantling equipment,
- ✓ wheel alignment
- ✓ forklifts, etc



Part III DRT Solution

Power Supply and Charging

❑ Large-capacity lithium-ion supercapacitor

- ✓ Capacity: 130kWh (3 car)
- ✓ Charging time: Fully charged in 12 minutes
- ✓ Range: 30km
- ✓ Lifespan: 10-year with little maintenance

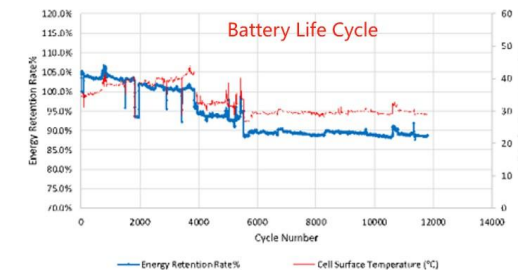
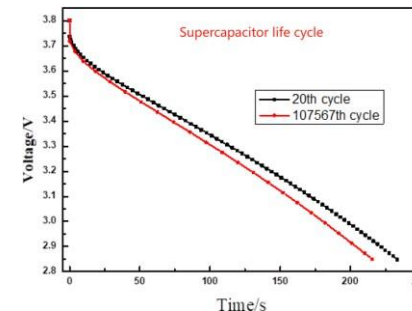


Quick Charging: 750V(adjustable), 1000A

Slow Charging: 380V (adjustable) , 250A/400A

❑ Hydrogen fuel cell with auxiliary supercapacitor

- ✓ Capacity: 570kWh (3 car)
- ✓ Hydrogenation time: Fully fill up in 12 minutes
- ✓ Range: 150km
- ✓ Lifespan: 5-year with little maintenance
- ✓ Super capacitor is used as an auxiliary power source, 15km can be achieved in the event of hydrogen fuel cell failure.



Assuming the use of fast charge, the line length is 6km, and the terminal station can be charged for 1.5 minutes:

Energy consumption for one trip: $4\text{kWh/km} \times 6\text{km} = 24\text{kWh}$

Terminal station recharge: $12\text{kWh/min} \times 1.5 = 18\text{kWh}$

Remaining capacity of the capacitor after charging: $130\text{kWh} - 24\text{kWh} + 18\text{kWh} = 124\text{kWh}$

DRT vs Trams &BRT Technical Parameters

ITEM	LRT(5-Module)	DRT(4-Module)	BRT(2-Module)
Driving control	Bi-direction	Bi-direction	One direction
Car length	32.6m	39.5m	18m
Car width	2650mm	2500mm	2500mm
Axle load at- full load	12.5ton	7.5ton	7ton
Maxi Passenger capacity(6/m ²)	300	332	150
Min turning radius	25m	15m	24m
Floor Structure	low floor	low floor	low floor
Acceleration	≥1m/s ²	≥1m/s ²	Each product is different
Average safe brake deceleration	≥1.5m/s ²	≥1.1 m/s ²	Each product is different
Emergency brake equivalent deceleration	≥2.8m/s ²	≥2.0 m/s ²	Each product is different

Part III DRT Solution

Experience

Shanghai Lingang T1

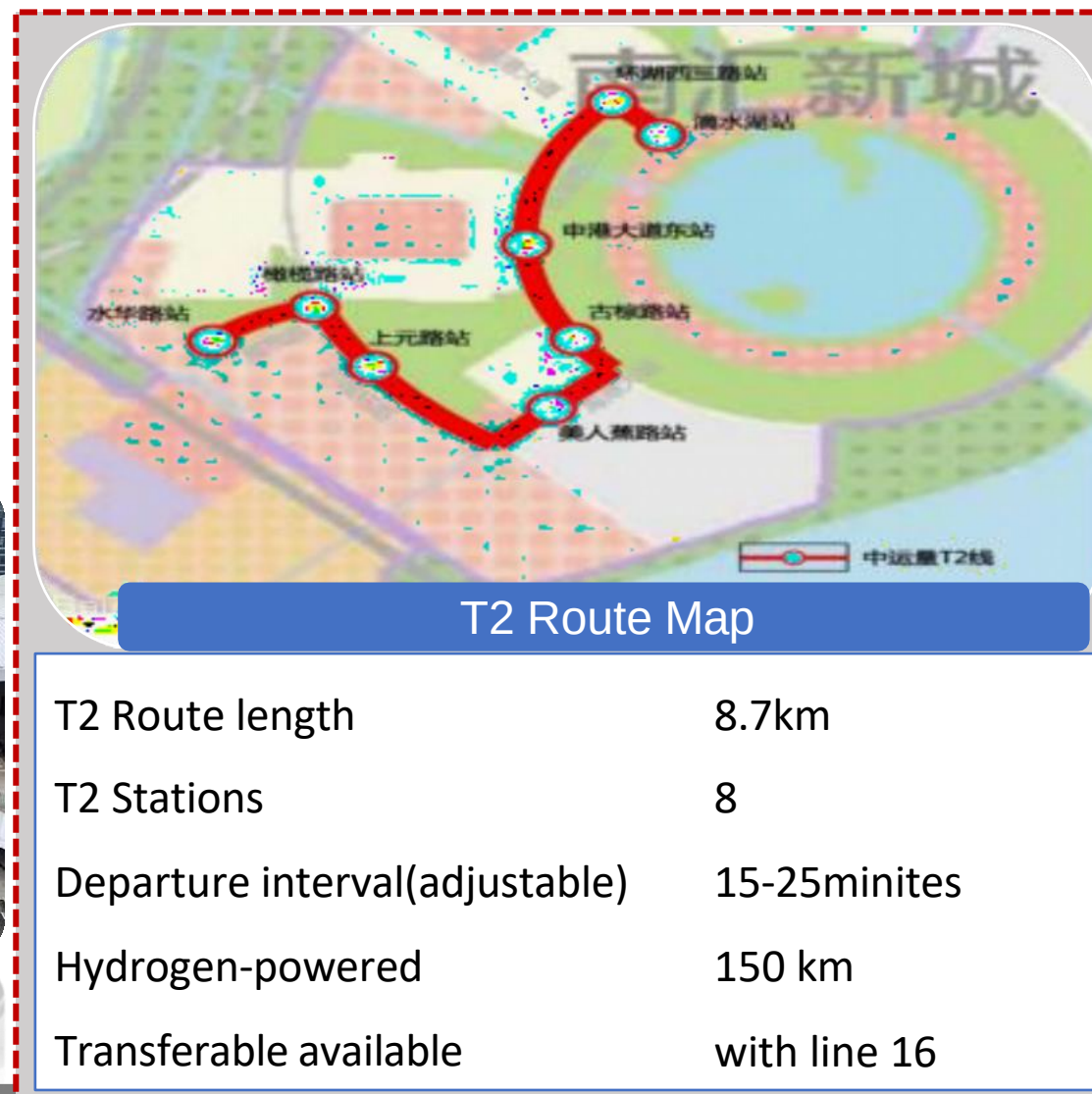
- ✓ 18th, AUG, 2020, the world's first DRT independently developed by CRRC.
- ✓ 1st, JAN, 2021, trial operation.
- ✓ 30th, JUN, 2021, officially operation.

T1 Route length	21.7km
T1 Stations	20
Departure interval(adjustable)	8-20 minutes
Super Capacitor-powered	30 km



Shanghai Projects

- ✓ Operation in October 2022
- ❑ **Shanghai Lingang Line T2**
- ✓ Hydrogen energy
- ✓ 5 trainsets with 3 cars formation
- ✓ Depot at Huabai Road. Hydrogen refueling station at depot



T2 Route Map

T2 Route length	8.7km
T2 Stations	8
Departure interval(adjustable)	15-25minites
Hydrogen-powered	150 km
Transferable available	with line 16

Part III DRT Solution

Experience

Shanghai Projects

- ✓ Hydrogen energy
- ✓ **Shanghai Lingang Line T6**
- ✓ 7 trainsets with 3 cars formation
- ✓ Depot at Huabai Road. Hydrogen refueling station at depot



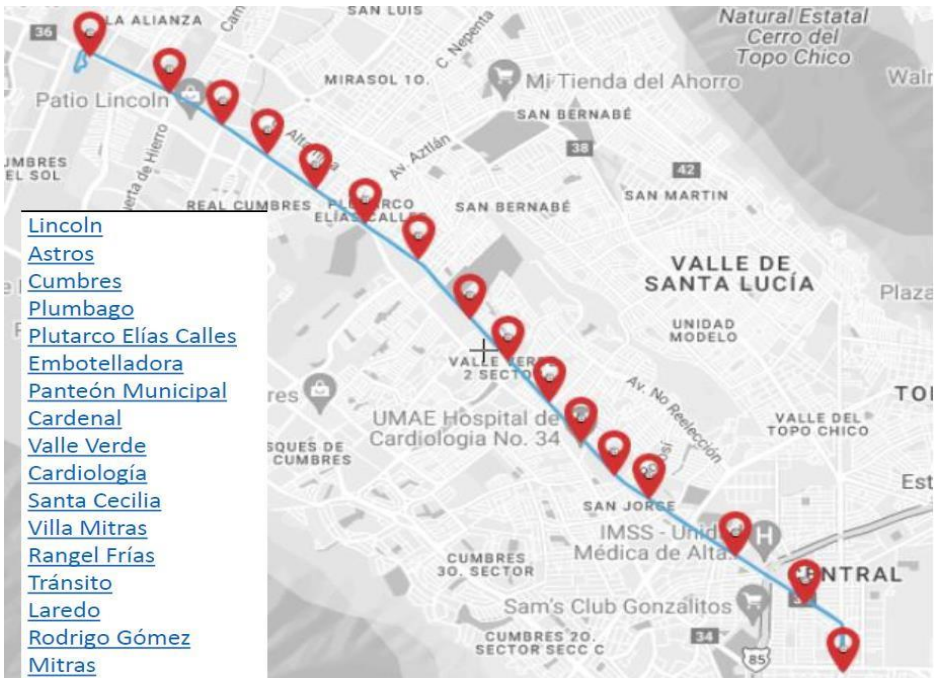
T6 Route Map

T6 Route length	10.6km
T6 Stations	5
Departure interval(adjustable)	15-25minites
Hydrogen-powered	150 km
Transferable available	with T1



Demonstration Line in Monterrey

- ✓ Mixed operation with the existing BRT fleet
- ✓ Operation at Feb 2024
- ✓ Main line uses manual driving to demonstrate the vehicle to the public.
- ✓ Operation by CEMEX
- ✓ Demonstration period: 1 year.



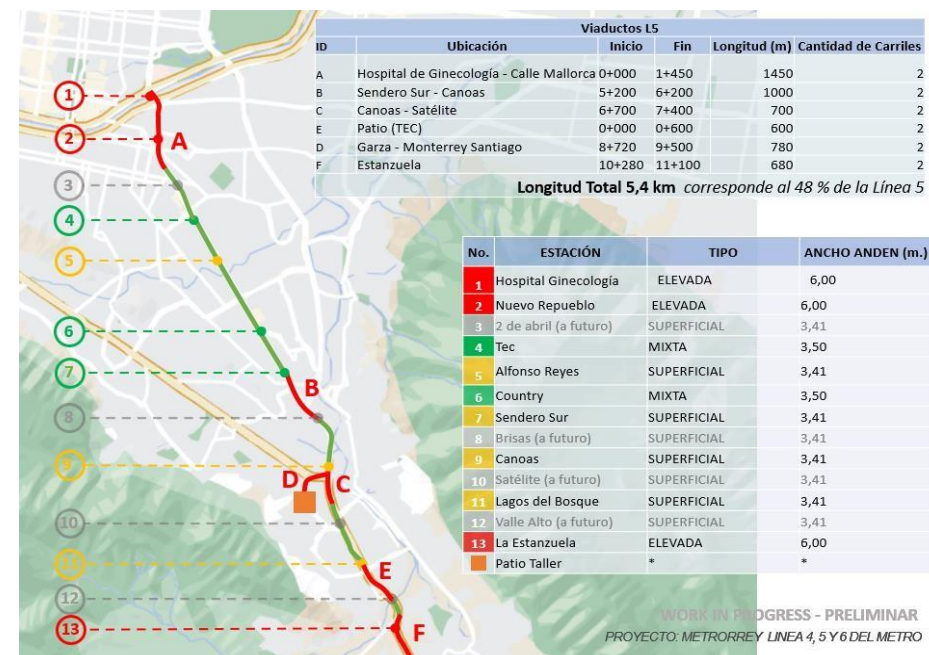
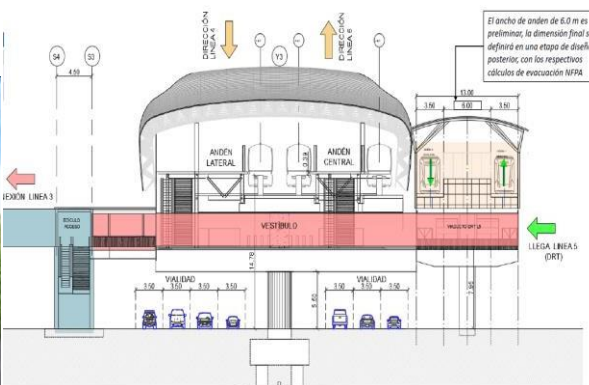
Demo Line Route length	11.5km
Stations	17
Departure interval(adjustable)	5 minutes
Super Capacitor-powered	30 km
Transferable available	with Metro L1

Part I DRT Solution

Experience

Mexico Line 5

- ✓ Turnkey Project include design, construction, E&M, Vehicle;
- ✓ Consortium with local partner
- ✓ Operation by Metro Monterrey
- ✓ Operation in 2026



L5 Route length	11km
Stations	13
Departure interval(adjustable)	10-30 minutes
Super Capacitor-powered	30 km
Transferable available	with L4&L6

THANK YOU

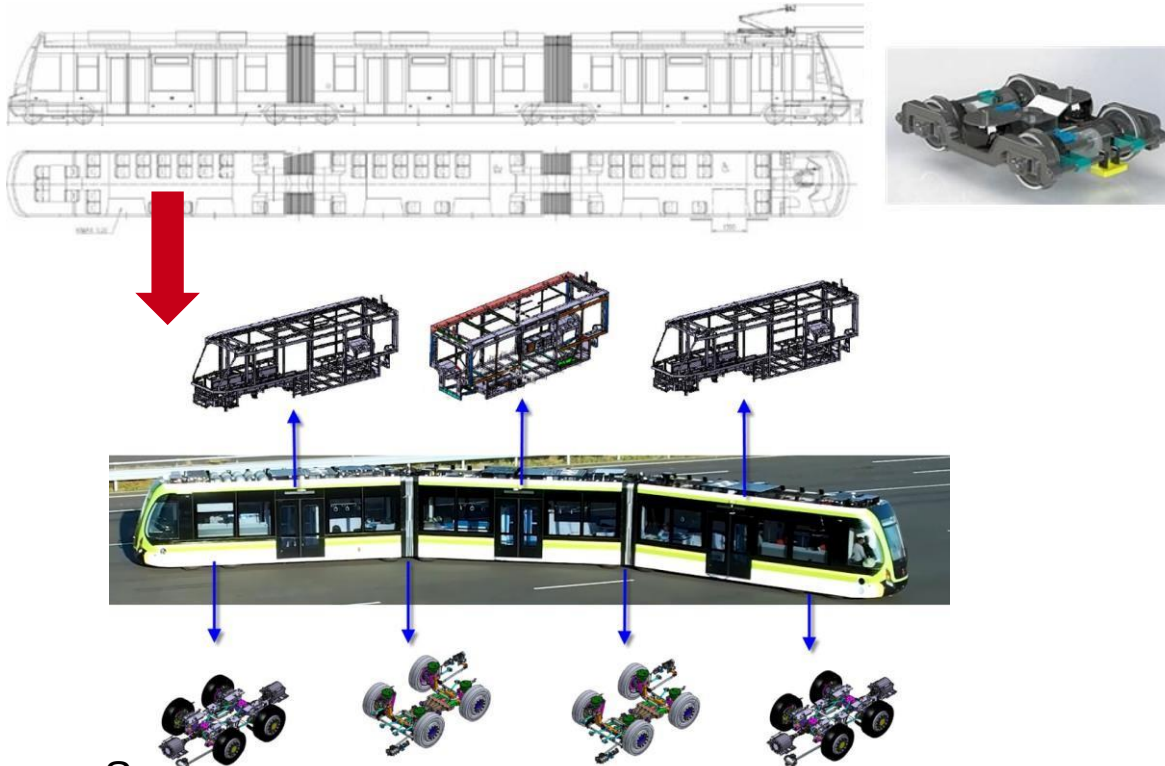
DRT Comparison with BRT

中车南京浦镇车辆有限公司

Part3 Compare between DRT & BRT

Structure

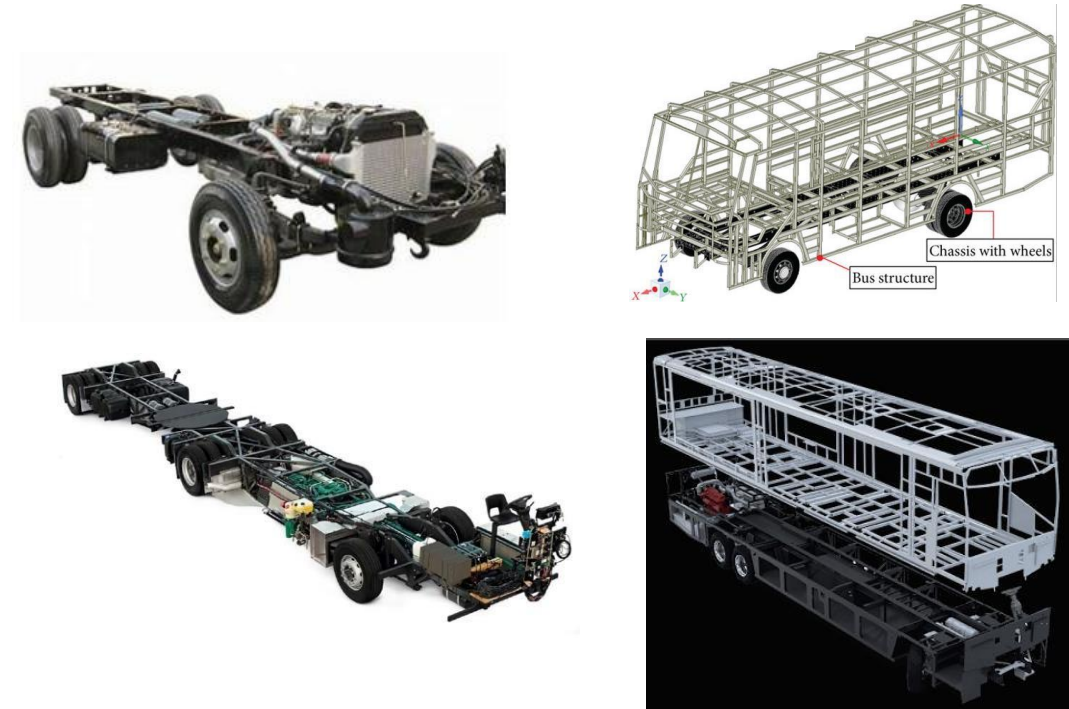
DRT



Summary:

- ✓ DRT was developed on the basis of trams(VLT), using rail transit standards.
- ✓ BRT uses regular buses, or articulated buses that extend from regular buses, using road vehicle standards.
- ✓ The rail transit standards requires that the design life of railway vehicles is not less than 30 years

BRT



1. Railway Standard and contract requirements

Components	Standards	Clause	Requirement
Bogie	UIC 515-4	6.1.3	The number of fatigue test cycles has been chosen to allow global simulation of a 30-year service life, based on 200.000 km/year.
Electrical components	EN 50155	6.2	The useful life of the electronic equipment shall be specified according to one of the following classes: L4-20 years (Unless otherwise specified, the life class L4 applies)
Vehicle	GB 50157	4.3.4	The design life of the vehicle structure shall not be less than 30 years

2.4.7.1 The annual mileage of the fleet is 2,550 car-kkm

- 20 hours per day for not less than 30 consecutive days without any maintenance, but only visual inspection at weekly intervals.
- The useful life of the vehicle under an adequate maintenance regime as defined in the O&M manuals to be provided by the Contractor shall not be less than 40 years except for the LRV interior finishing where a minimum 20 years design life is required.

- ✓ Every project will test according to the standards and contract

Assessment Summary

Requirement	Compliance Status
PS K1846-15E	compliant
EN 12663	compliant
EN 15227	compliant
Static Proof Load Test	compliant
Mainline Dynamic Test	compliant

Serial No.	Ambient temperature at the outer surface of the insulation layer /℃	Hours	Life-time/years (Remark:19 hours per day)
1	30	1080226	156
2	40	555394	80
3	50	297562	43

According to the contract, the design service life of Hong Kong LEV is not less than 40 years. According to BS5768, the process of evaluation will be done with the load AW2, the cumulative damage of carbody structure does not exceed 1.0. Then the evaluation of service life will be guaranteed.

a. Analysis of the relation between Load and passenger flow
Based on the statistics of passenger flow one year, get the relation between the load and the percent of passenger data. From this picture, it is obviously that the passenger load is far lower than its load AWZ.

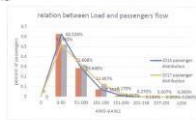


Figure 18 Passenger statistic

b. Get 4 mileage one year

According to the MTR information, light rail vehicles operate 85,000 km each year. The expected service life is 40 years.

d. Translate to the design miles of one year, and get the accumulative damage will be calculated

in one year with the passenger load AW2.

The utilization factor (UF) is:

CF = 0.5, *5000km*40years

D is the accumulation damage of each round-trip. It is the average distance of each round-trip

2.Method

- ✓ Use metal material as much as possible.
- ✓ Use industrial quality of electrical components
- ✓ Reserve a higher safety factor
- ✓ Follow the standards requirements ,the parameter defined in standards already consider the 30 years life.(Such as BS 7608, Fatigue strength curve (S-N curve))

4. Existing project experience proof

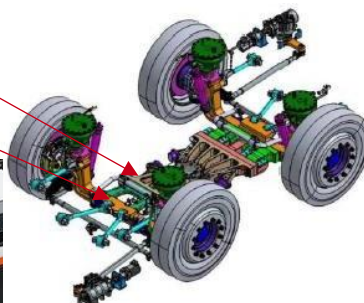
- ✓ Shanghai Metro Line 1 :1992-2023.
- ✓ MTR, M train:1994~till now
- ✓ MTR, light rail ,1988~till now.



Part3 Compare between DRT & BRT

Segments Connection

DRT



Summary:

- ✓ The articulated technology used in DRT can avoid “up-and-down” movement of the vehicle and improve comfort.
- ✓ The DRT has shorter gangway length, allowing more space for passengers.

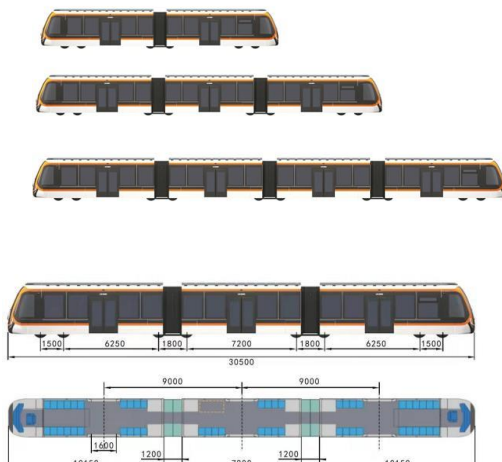
BRT



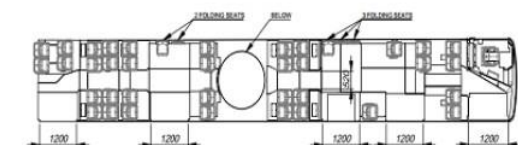
Part3 Compare between DRT & BRT

Passenger capacity

DRT



Formation	2 car	3 car	4 car
Length/m	21.5	30.5	39.5
Seating Capacity/Person (Flexible adjustment)	40	56	72
Rated Passenger Capacity/4 Person	120	179	248
Rated Passenger Capacity/6 Person	162	241	332
Overloaded Passenger Capacity/ 8 Person	202	302	416



BRT

Body type	Length [m]	Max. payload [t]	Max. no. passengers
12 m single-deck	12	7.9	115
18 m articulated	18–18.75	10.7	156
25 m bi-articulated	24.8	13.7	200
2-axle double-deck	10.5–12	7.0	101
3-axle double-deck	12–13.7	8.7	126

Diesel BRT

Dimensions and weights			
Model	12.0 m	18.0 m	18.7 m
Length (m)	12.00	17.85	18.55
Width (m)	2.55	2.55	2.55
Height (m)	3.30	3.32	3.32
Permitted GVW (kg)	19,500	29,000	29,000
Passenger capacity			
Model	12.0 m	18.0 m	18.7 m
No. of passengers, max	95	150	145
No. of seats, max	38+1	49+1	53+1

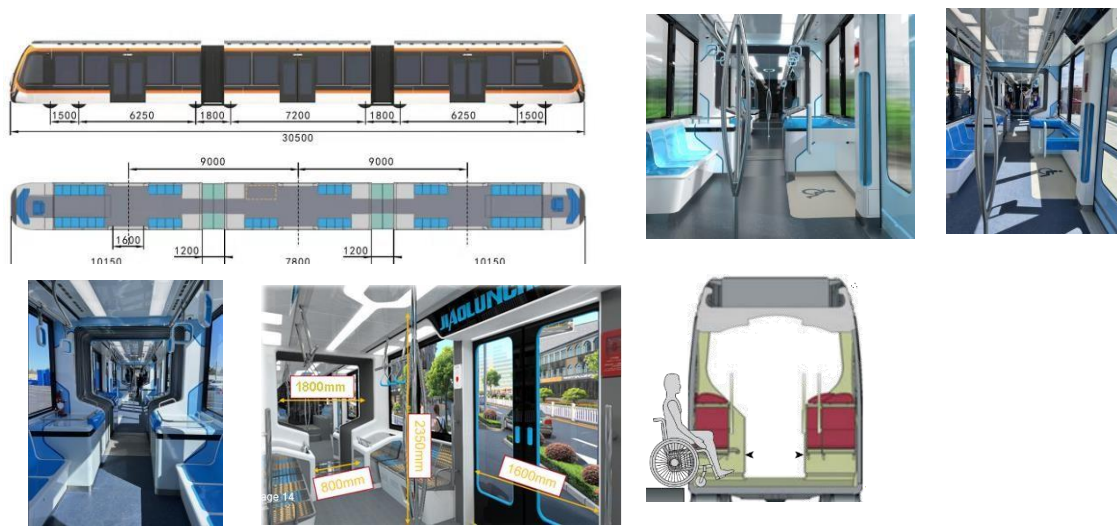
Electrical BRT

Summary:

- ✓ DRT has a higher passenger capacity than BRT
- ✓ DRT requires fewer drivers than BRT
- ✓ For the same passenger flow, DRT can be equipped with fewer vehicles than BRT

Saloon Layout

DRT



Flat floor , Max 332 person(4 car, 6 person per m²)

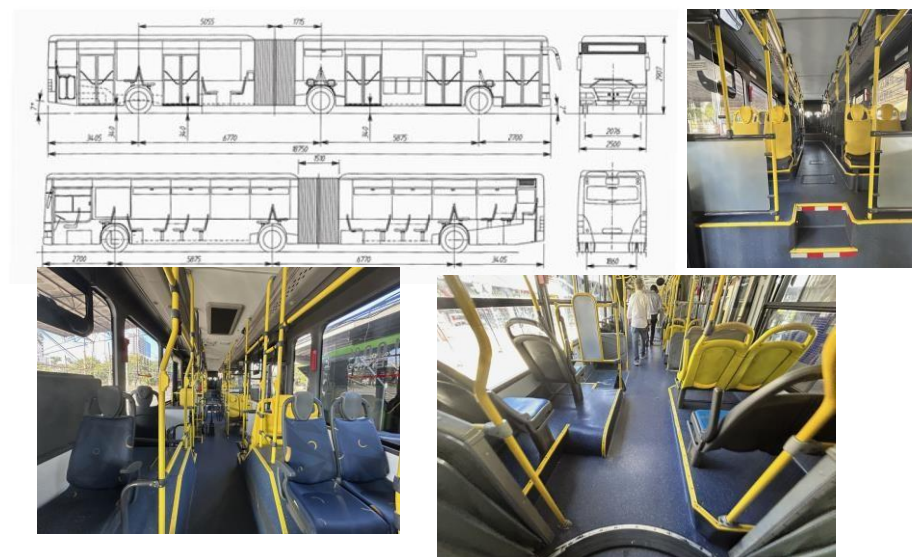
Summary

- The saloon area of the DRT is more spacious and wheelchairs can easily pass through each car. .
- There are many steps in the saloon of BRT, which affect the flow of passengers
- DRT have higher space utilization.

BRT

No. of Seats

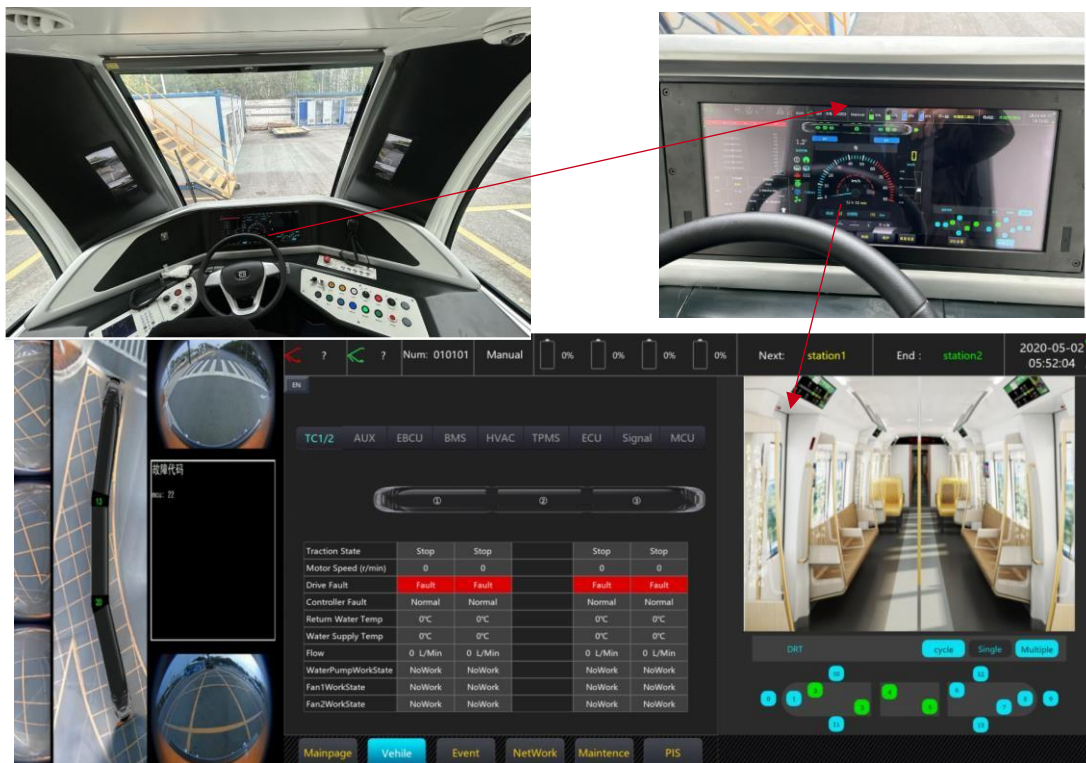
53 + 1 (+80 Standing)



More steps in saloon, Max 200 person(25m)

Cab Layout

DRT



BRT



Summary

- DRT equipped with “Train control and management system”, which has Driving assistance, Fault record, Intelligent diagnosis, Maintenance assistance function.

Axle Load

DRT



Max Axle load: 7.5 ton

BRT



Body type	Length [m]	Max. payload [t]	Max. no. passengers
12 m single-deck	12	7.9	115
18 m articulated	18-18.75	10.7	156
25 m bi-articulated	24.8	13.7	200
2-axle double-deck	10.5-12	7.0	101
3-axle double-deck	12-13.7	8.7	126

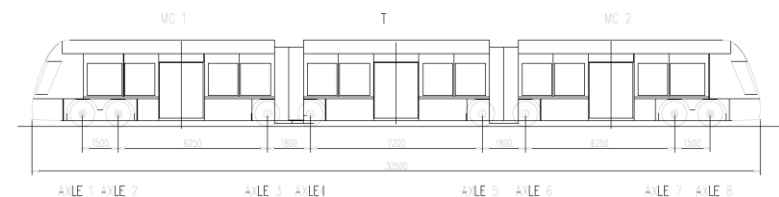
Max Axle load: 13.7 ton

- Summary:
- ✓ DRT has lower axle load than BRT
 - ✓ DRT has less impact on the road

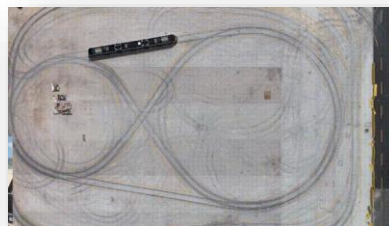
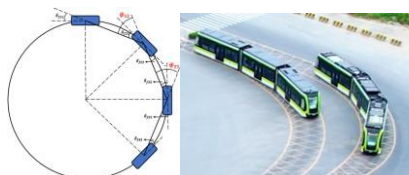
Part3 Compare between DRT & BRT

Steering

DRT



	AXLE 1	AXLE 2	AXLE 3	AXLE 4	AXLE 5	AXLE 6	AXLE 7	AXLE 8
POWER	Motor (driven)	Motor (driven)					Motor (driven)	Motor (driven)
Steer	Active - Steerable	Steerable via link to Axle 1	Active Steerable				Steerable via link to Axle 8	Active - Steerable



Min turning radius: 15m

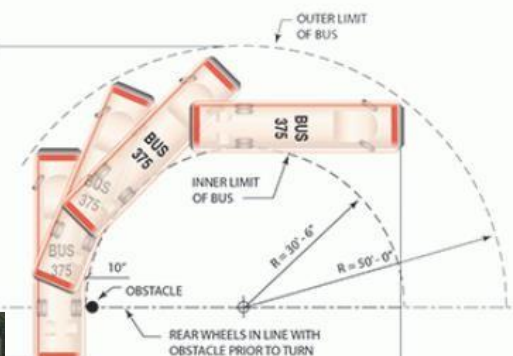
All-wheel steering

BRT



Bus Turning Ratios

90 Degree Turn 40 Foot Bus



Front-wheel steering

Summary:

- ✓ DRT adopts all-wheel steering, so the turning radius can achieve R15,
- ✓ BRT adopts front wheel steering mode, the longer the vehicle, the larger the sweeping space of the vehicle
- ✓ DRT can be controlled more precisely and take up less space when using magnetic nail guidance

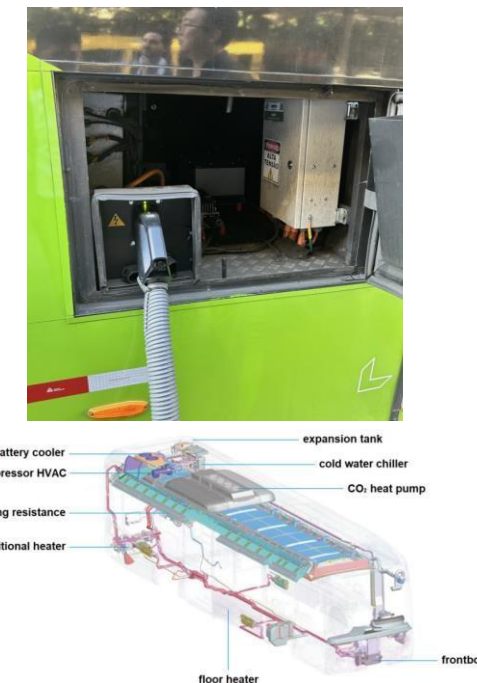
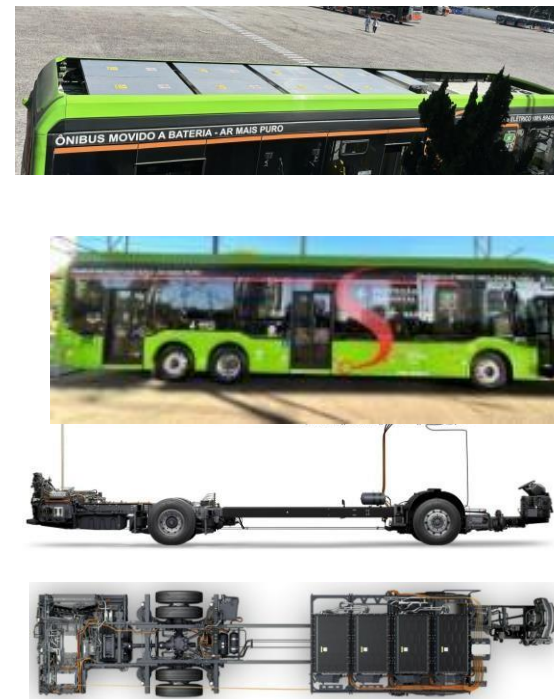
Part3 Compare between DRT & BRT

Equipment

DRT



BRT



Summary:

- ✓ DRT follow railway design requirement, use redundancy design, the number of equipment is much higher than BRT.
- ✓ The DRT is equipped with more intelligent systems, and the whole vehicle has more than 8,000 cables, used to manage and control vehicles

Part3 Compare between DRT & BRT

Performance

DRT

• Type of Motor	Permanent magnet motor
• Nominal Power	120kw*4=480kw
• Maximum Power	180kw*4=720kw(Under Traction) 220kw*4=880kw(Under Brake)
• Start torque	7600Nm
• Maximum gradient	15%
• Maximum axle load	7,500kg

BRT

Engine	D8K350
Emission standard	Euro 6
Engine system	EGR, Common Rail
Displacement (dm³)	7.7
Cylinders/arrangement	6/in-line
Output (hp)	350
Output ISO 1585 (kW)	258
Torque ISO 1585 (Nm)	1,400
at engine speed (rpm)	1,200-1,600

Diesel BRT

Driveline

Electric motor, output max (kW)	200	2×200	2×200
Max wheel torque (Nm)	19,000	31,000	31,000

Electrical BRT

Summary

- ✓ The DRT has more traction capacity and can still achieve 15% of the climb capacity.
- ✓ The DRT will priority use regenerative braking, which is more energy efficient.

Part3 Compare between DRT & BRT



Door System

DRT



Type	Plug in sliding door
Number	6(both side)
Size	1600(width)*1900(height)
Main Function	Obstacles detection/remote maintenance/ Door open and close indication/safety lock/bypass

Summary:

- ✓ The DRT sliding door has a better appearance and does not occupy the door entrance space
- ✓ The larger size of the DRT door allows passengers to quickly get on and off the train

BRT



• Type	Folding door
• Number	3~4
• Size	1300(width)*1900(height)
• Main Function	Open and close

ACV system

DRT



- Air Conditioning
- (3 in total, 1 for each car)

Cooling Capacity:3*29kw
Heat:3*22kw
Air Flow:3*3500m3/h
Fresh Air:3*850m3/h

Summary

- ✓ The DRT is equipped with more powerful air conditioning.
- ✓ DRT air conditioning with fresh air function, can make passengers feel more comfortable.
- ✓ DRT air conditioning can be self-diagnosed, easy to maintain, and can be controlled centrally or separately.

BRT



Climate system

Model	12.0 m	18.0 m	18.7 m
Cooling capacity			
Roof unit, max (kW)	25	2×25	2×25
- optional separate driver AC (kW)	5.5	—	—
Heating capacity			
Roof unit			
- heating pump (kW)	16	2×16	2×16
- electric heater (kW)	40	2×40	2×40

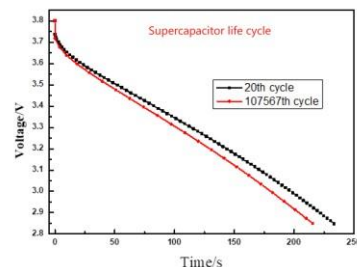


Onboard Energy

DRT

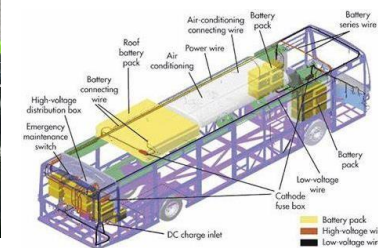


• On board energy	super capacitors or hydrogen
• Installed power (super capacitor)	130kwh
• Charging time (Use pantograph)	charging power:720kw charging time: 12min
• Charging time (Use charging pile)	charging power:140kw charging time: 60min
• Use life	10 years, not affected by the number of charges

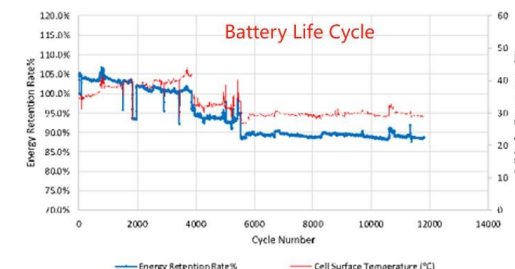


Suggest to use supercapacitors or hydrogen
Also can use battery

BRT



Model	12.0 m	18.0 m	18.7 m
Charging			
OppCharge max charge power (kW) max (kW)	300	400	450
CCS max charge power (kW)	150	150	150
400 V AC max charge power (kW)	11	—	—
Energy storage			
Battery capacity (kW)	Up to 330	Up to 330	Up to 396
Battery	Lithium-ion battery. Automatically temperature-controlled.		



BRTS basically use lithium iron phosphate, which has a short life and a long charging time

Summary:

- ✓ DRT use supercapacitor, can quick charging at terminal station
- ✓ BRTS basically use lithium iron phosphate, which has a short life and a long charging time
- ✓ Supercapacitors have higher safety and longer life than lithium iron phosphate

Part3 Compare between DRT & BRT

Passenger Information System



DRMD



FDU



PECU



SDU



CCTV



BRT

Summary:

- ✓ The DRT is equipped with a variety of passenger information system devices, including video and audio
- ✓ DRT can realize automatic broadcast arrived station names
- ✓ Routes and stops can be set by the OCC or by the driver

Driver Assistant

DRT



Laser radar

Binocular vision

Millimeter
wave radar

Ultrasonic radar



360
panoramic
camera



BRT



Rear-view camera



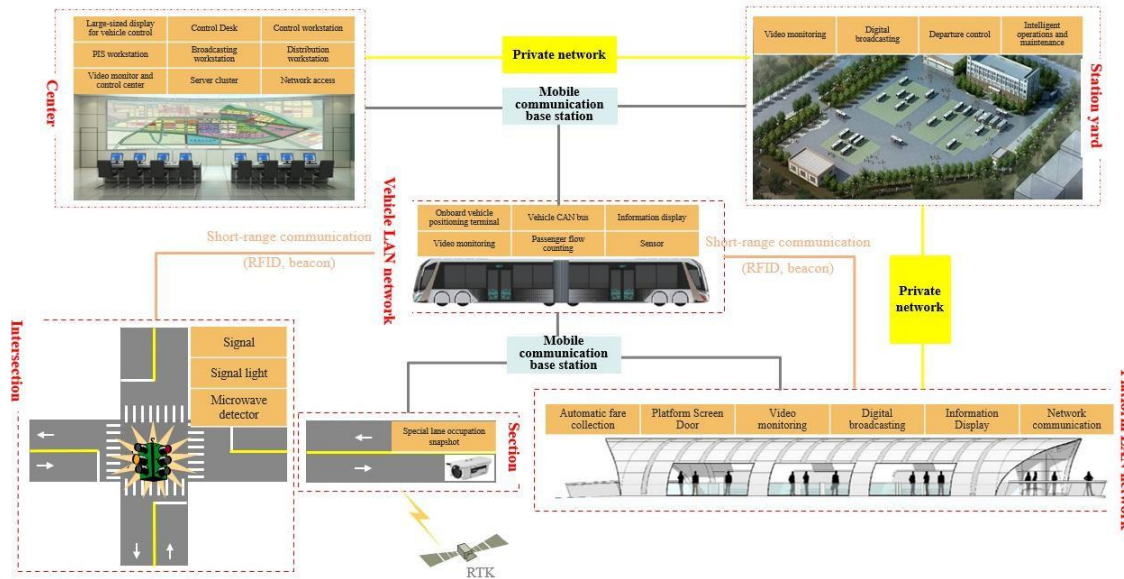
Ultrasonic radar

Summary:

- ✓ DRT is equipped with an advanced automatic obstacle detection device
- ✓ DRT enables automatic GOA2 or L3 level autonomous driving in the case of magnetic nail guidance
- ✓ DRT is equipped with more driving assistance devices, which can also help the driver better drive the vehicle in the case of manual driving

Operation

DRT



BRT

BRTS operation & administration

Operational requirements of BRTS

- BRT Infrastructure (Running Ways)
- BRT stations & platforms
- BRT vehicle fleet
- BRT ITS
- BRT integration
- BRT fare
- BRT marketing and branding
- BRT Infrastructure supporting facilities
- BRT fleet supporting facilities and services

Administration requirements of BRTS

- BRT Infrastructure providers (public, private)
- BRT operators
- BRT planning and regulator agency
- BRT services and operational plan

Summary:

- ✓ DRT use rail transit concept, and more automated ways are used to manage the operation.

Standard

DRT

• Fire Standard	EN 45545
• Safety regulation	EN 12663 P-V, EN 15227
• NOISE	ISO 3095, ISO 3381 , < 75dB(A)
• Driver cab	UIC 651
• EMC	EN 50121
• Holding brake	EN 13452
• Driving assistance	TCMS, 360 panoramic view, Lidar, binocular vision...

BRT

SECURITY AND REGULATION

Compliance with fire-resistance:
Compliance safety regulation:
AVAS(Acoustic Vehicle Alerting System) integrated according to:
Compliance with:
Driver are in accordance with:
Electromagnetic compatibility:
Creepage and Hillholder function:
EcoAssist:
Eco-mode:

Regulation 118R, annex 6,7 and 8
With ECE-R66/02

R138 regulation
Standard ITxPT
ISO16121, VDV234 and EBSF
Regulation 10R

✓
Efficient assisted driving
Intelligent management of air conditioning once the vehicle is switched off

Summary

- DRT is designed using railway standards and is more stringent.
- The DRT has more driving assistance functions and can achieve a certain degree of autonomous driving
- DRT consider both structure safety and crash safety . The front end of the DRT is equipped with an energy absorption area, which can better protect the driver and passengers. The structural strength of BRT is only related to rollover, not longitudinal compression and fatigue strength. The collision performance of BRT vehicles is lower than the requirements of rail transit standards, and drivers and passengers are more likely to be injured after vehicle collision.

Design Concept

DRT design based on rail transit concept

➤ RAIL

Magnetic markers are used to form a virtual track to control the vehicle on its route, making it **safe, fast and comfortable**;

➤ Smart

Automatic and intelligent driving, real-time positioning, coordination between OCC and vehicles; **Redundant design**, high reliability, operations not affected by a single failure;

➤ Bi-direction driving

Door opening on both sides, two cabs allow bi-direction driving, making it more convenient for road and platform design;

➤ Flexible adjustable

Adjustable car formations, without affecting the turning radius and space;

➤ Long life cycle, designed with a 30-year service life.

BRT Design based on bus concept

➤ Share the Road

Using common roads or dedicated routes, it relies on the driver to observe the road surface, and the riding comfort also depends on the driver's driving skills;

➤ Manual driving by drivers;

➤ Redundancy not considered, directly withdrawn from operation in case of power or braking failure;

➤ One-direction driving, door opening on one side, platforms designed on the same side;

➤ Double articulation at most. The longer the car, the larger the turning radius, and the more severe the tail sways;

➤ Short service life, usually 8 to 10 years.

Design Concept

DRT design based on rail transit concept

- Customized product

Every project will be designed according to each customer's needs and its service environment;

- Standard compliance

Compliance with both rail transit and road vehicle standards. More stringent requirements for design and manufacturing;

- A variety of qualifications and certifications

Rail transit standards: EN 12663, EN 45545, EN 50121, EN 50126, EN 50128, EN 15085, DIN 6701, etc.;

Road traffic standards: NOM-012-SCT-2 and other NOM standards, NMX standards, UNECE or FMVSS standards and directives;

- Available certifications: ECE, NOW, etc.

Take fire protection as an example, only the combustion properties of interior materials are required according to UL or FMVSS, whereas EN 45545 not only has requirements for materials, but also for the vehicle structure, fire prevention, firefighting, evacuation and other aspects in detail.

BRT Design based on bus concept

- Mass production

A product of mass production, and usually only a fixed number of models are available for customers to choose from;

- Standard compliance

Only road vehicle standards are followed;

- Qualifications and certifications

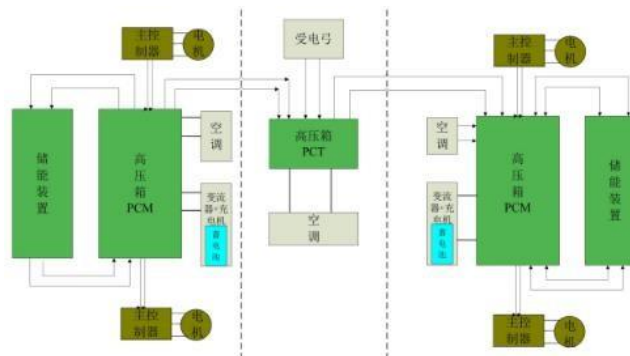
only provide relevant testing and certification of the automobile industry;

Road traffic standards: NOM-012-SCT-2 and other NOM standards, NMX standards, UNECE or FMVSS standards and directives, but the standard requirements are far lower than those of rail transit;

Safety design

DRT

- All critical system designed redundancy.
- Vehicle will automatic brake under below condition:
 - Train overspeed
 - Change of normal operation route
 - Door not closed properly or opened
 - Driving direction changed
 - Invalid brake command
 - The vehicle trajectory is severely deviated
 - The line magnetic nail signal is continuously lost
 - Rubber tires have safety wheels inside
 - Brake system has major failure
- Multiple braking method,
 - Brake pedal
 - Mushroom button
- Emergency communication Device
- Brake and traction interlock.
- Normal lighting and emergency lighting
- Obstacle detection



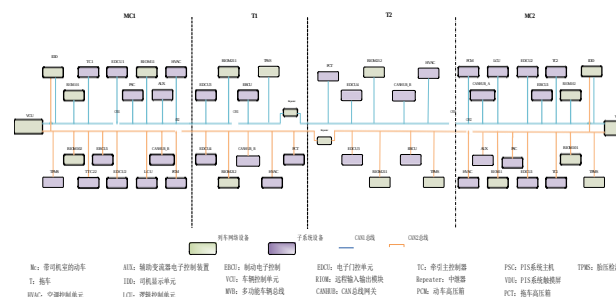
BRT

- Do not consider redundancy
- Brake controlled by driver.
- Only Rubber tire
- Only lighting,

Smart Design

DRT

- All critical system designed redundancy.
- Autonomous driving based on magnetic nails;
- Virtual rail;
- Digital map;
- Body attitude correction (Angle sensor, inertial navigation)
- Obstacle detection
- Dynamic route maps
- Automatic station announcement
- Bi-direction driving



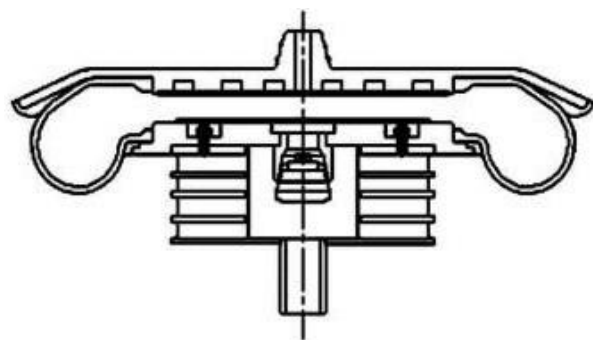
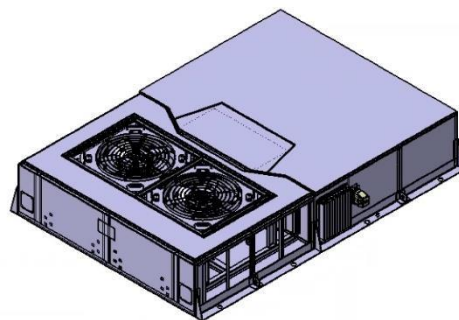
BRT

- Brake controlled by driver

Comfort Design

DRT

- Air condition has fresh air(Reduce CO2 concentration)
- Jerk limit
- Low floor
- Broad vision
- Door with big open width



BRT

- No fresh air ,only cooling and heating.



DRT vs Trams & BRT Technical Parameters

DRT vs Trams&BRT

ITEM	LRT(5-Module)	DRT(4-Module)	BRT(2-Module)
Driving control	Bi-direction	Bi-direction	One direction
Car length	32.6m	39.5m	18m
Car width	2650mm	2500mm	2500mm
Axle load at- full load	12.5ton	7.5ton	7ton
Maxi Passenger capacity(6/m ²)	300	332	150
Min turning radius	25m	15m	12~24m
Floor Stucture	low floor	low floor	low floor
Acceleration	≥1m/s ²	≥1m/s ²	Each product is different
Average safe brake deceleration	≥1.5m/s ²	≥1.1 m/s ²	Each product is different
Emergency brake equivalent deceleration	≥2.8m/s ²	≥2.0 m/s ²	Each product is different

1. Road Requirement

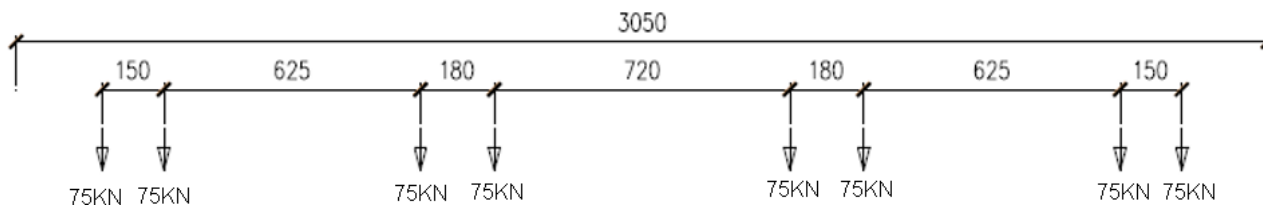
- ✓ Trunk road. The design resilience modulus value of the top surface of the roadbed $\geq 40\text{MPa}$
- ✓ Branch road. The design resilience modulus value of the top surface of the roadbed $\geq 35\text{MPa}$

2. Pavement Structure

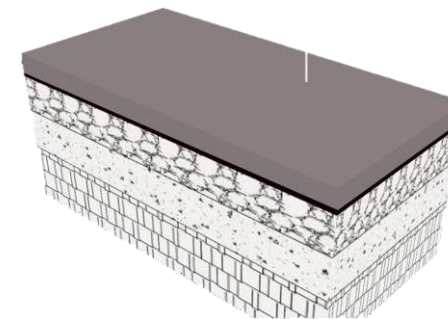
- ✓ Cement Concrete Road (preferred)
- ✓ Asphalt road surface

3. Load Requirement

- ✓ 7.5 t Ref. Trunk road defined by standard CJJ37 or similar standards



数轨（DRT）列车荷载计算图示（单位：cm，kN）



26cm C35 Cement concrete	26cm C35水泥混凝土
20cm C30 Cement concrete (Double steel mesh)	20cm C30水泥混凝土（双层钢筋网片）
15cm Gravel sand	15cm 砾石砂
Raw soil crushing	原土碾压
Cement paste	水泥净浆
Original surface layer	原面层
Original base layer	原基层
Original base	原底基层

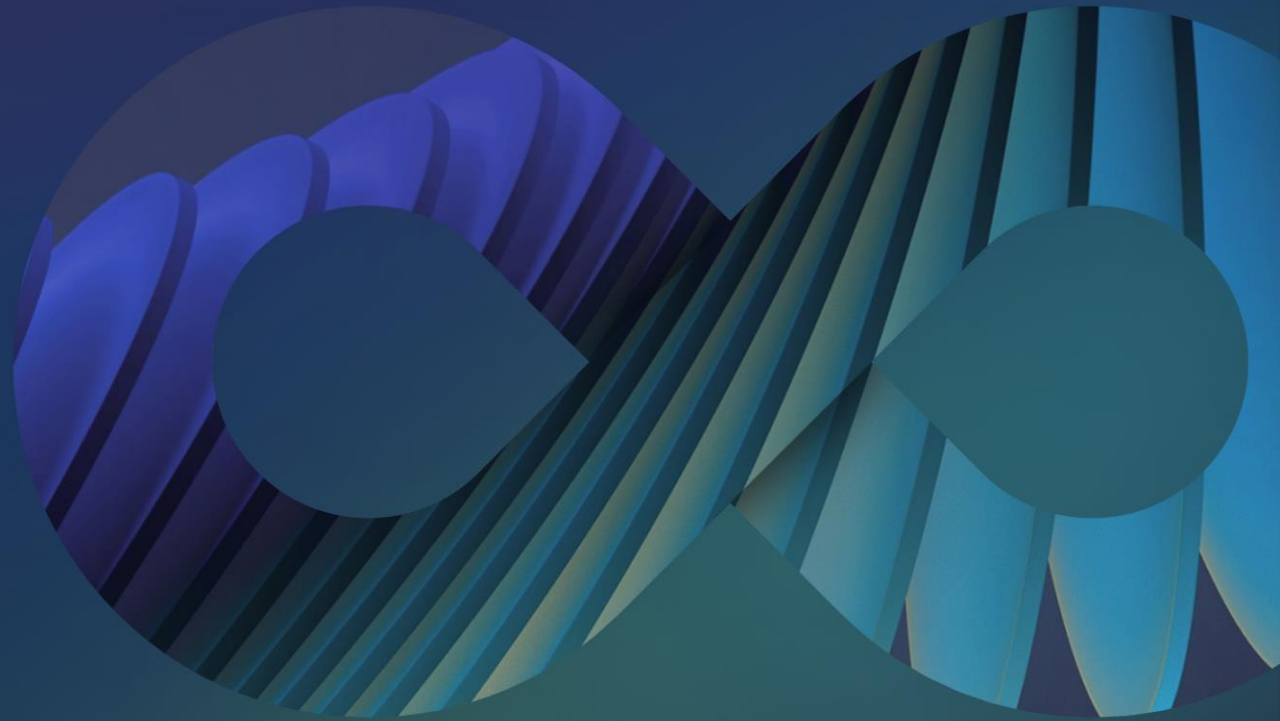
〔感谢聆听！〕



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03 de abril de 2024



SIEMENS

Com nossas soluções, estamos enfrentando os maiores desafios do nosso tempo
... Abaixo do nível de Grupo, haverá 3 empresas ...

**Siemens
Healthineers**

**Siemens
Industry, Infrastructure and Mobility**

**Energy
Energy**

Siemens

Digital
Industries

Mobility

Smart
Infrastructure

**Siemens
Healthineers**

**Siemens
Energy**

A Siemens Healthineers, que é uma empresa de dispositivos médicos gerida separadamente e com ações na bolsa.

A Siemens Energy é uma empresa de energia formada pela cisão da antiga divisão de Gás e Energia do Grupo Siemens e inclui uma participação de 67% da Siemens Gamesa (Geração Eólica). Também é gerida separadamente e com ações na bolsa.

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Quem somos

SIEMENS

Digital Industries



Smart Infrastructure



Mobility



Siemens Healthineers



Siemens Energy



Somos a empresa de mobilidade mais diversificada e verticalmente integrada estruturada em cinco unidades de negócio



Rolling Stock

Material rodante de curta distância, regional e longa distância, soluções de produtos e sistemas para transporte de passageiros e carga



Rail Infrastructure

Produtos e soluções para automação ferroviária e eletrificação para Mainline, Carga e Passageiros



Customer Services

Serviços para material rodante e infraestrutura ferroviária, durante todo o ciclo de vida



Turnkey

Soluções ferroviárias completas integrando todo o portfólio ferroviário e além



Software

Soluções de software para planejamento de trens, inventário, reservas e emissão de passagens, mobilidade como serviço (MaaS)

Rolling Stock é um fornecedor global de material rodante e soluções de sistemas para transporte de passageiros e carga



High Speed
and Intercity



Commuter,
Regional and
Passenger
Coaches



Metros



Light Rail
and Val



Locomotives



Components

Light Rail

SIEMENS
Ingenuity for life



Avenio



Avenio M



Articulado ou multiarticulado, o que for mais adequado

SIEMENS
Ingenuity for life

Um passeio rápido como bonde ou trem leve

... até mesmo nas curvas mais apertadas



Avenio



Avenio M

Single- or multi-articulated, whatever fits best



Avenio - Basic technical data:

- **Single-articulation design:** Modules of approx. 9 m length, each supported by one central bogie
- **Vehicle length:** 2 – 8 modules (18 m – 72 m)
- **Vehicle width:** 2.3 m, 2.4 m, 2.65 m
- **Entrance / Floor height:** 300 / 350 mm (435 mm)
- **Car body material:** Steel, welded
- **Gauge:** 1435 mm
- **Max. axle load:** 10.5 t
- **Max. speed:** 80 km/h



Avenio M - Basic technical data:

- **Multi-articulation design:** Short bogie modules connected by hinged intermediate sections
- **Vehicle length:** 3 / 5 / 7 modules (21 m – 43 m)
- **Vehicle width:** 2.3 m, 2.4 m, 2.65 m
- **Entrance / Floor height:** 300 mm (360 mm)
- **Car body material:** Aluminum, welded
- **Gauge:** 1000 mm, 1435 mm
- **Max. axle load:** 12.5 t
- **Max. speed:** 70 km/h



Single- or multi-articulated, whatever fits best

Length

18 m



27 m



36 m



45 m



54 m



63 m



72 m



Number of passengers for different vehicle widths*:

	2.30 m	2.40 m	2.65 m	
	35 + 69 = 104	46 + 64 = 110	46 + 76 = 125	MD
	24 + 79 = 103	36 + 73 = 109	36 + 86 = 122	BD
	53 + 108 = 161	70 + 101 = 171	73 + 119 = 192	MD
	42 + 118 = 160	50 + 122 = 172	52 + 140 = 192	BD
	69 + 153 = 222	90 + 146 = 236	94 + 166 = 260	MD
	52 + 170 = 222	72 + 164 = 236	72 + 192 = 264	BD
	89 + 189 = 278	120 + 174 = 294	127 + 201 = 328	MD
	68 + 211 = 279	96 + 200 = 296	96 + 235 = 331	BD
	105 + 233 = 338	138 + 222 = 360	142 + 256 = 398	MD
	80 + 260 = 340	112 + 250 = 362	112 + 292 = 404	BD
	128 + 265 = 393	170 + 247 = 417	179 + 286 = 465	MD
	104 + 292 = 396	144 + 276 = 420	144 + 326 = 470	BD
	149 + 303 = 452	190 + 239 = 483	198 + 336 = 534	MD
	116 + 341 = 457	160 + 326 = 486	160 + 382 = 542	BD

* Number of seats + Standing room 4 persons per m²

MD = Mono-directional vehicle; BD = Bi-directional vehicle

**Avenio: Made for every infrastructure, every system
every need and for more passengers**

SIEMENS
Ingenuity for life



**Avenio – Result of 130 years of experience in tram manufacturing
and 20 years of expertise in the 100% low-floor market**

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Avenio Munich

SIEMENS
Ingenuity for life



Avenio: Doha Education City (Qatar)

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Ingenuity for life



Avenio M: Result of a continuous evolution, modularity and economic efficiency at its best

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Avenio M – Result of a continuous evolution with focus of improvements on reliability, safety and comfort

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Avenio M Ulm

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Our trams: Made for your cityscape and your budget

The window to your city

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Our trams: Also better for the environment

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Comparison with buses, LRT and metros

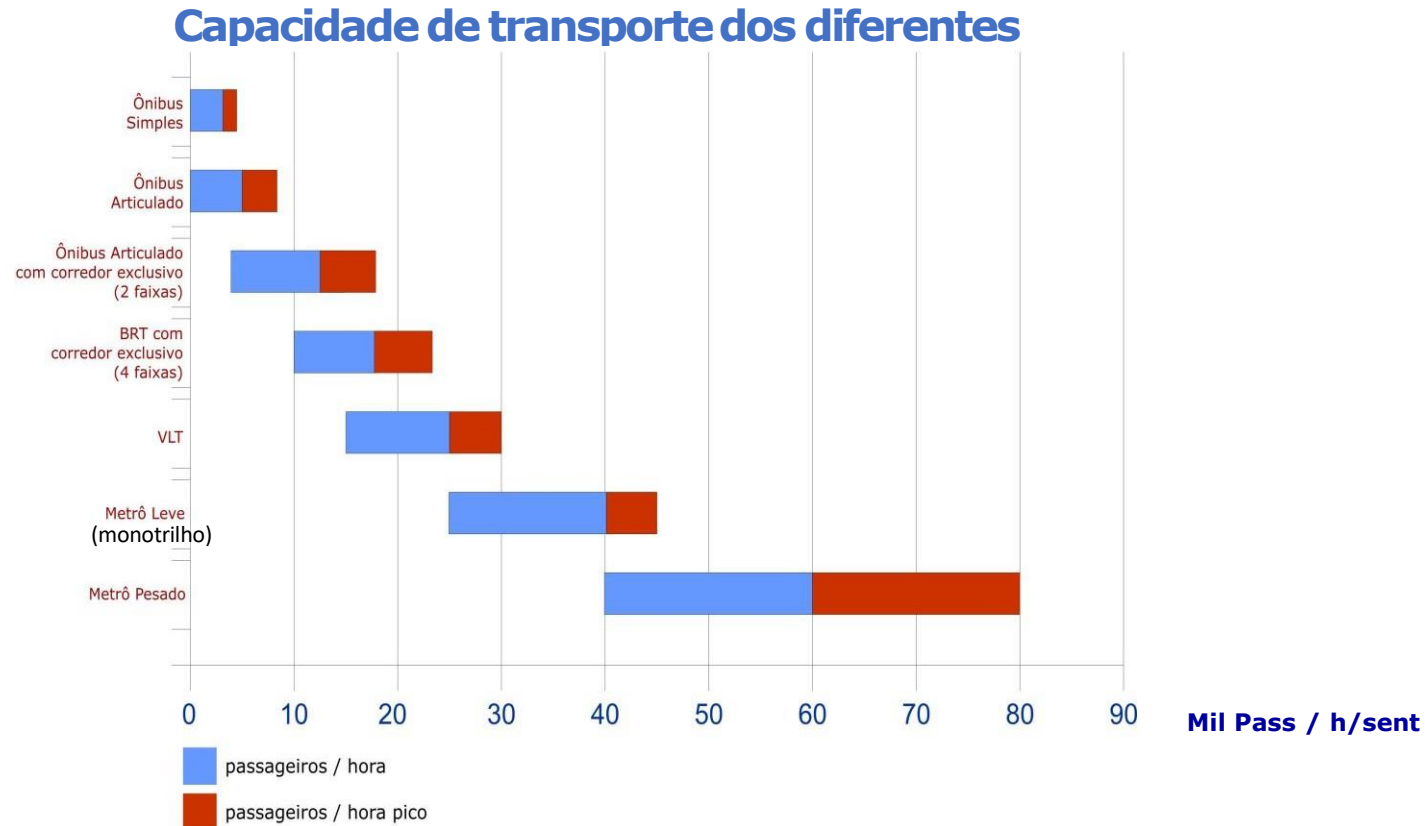
	Bus/tram	LRT	Metro
Curve radius	> 11 m	15 to 80 m	> 80 m
Gradient	</= 10 to 12%	</= 7%	</= 7%
Tunnel diameter (2L)	8 m	10 m	10 m
Track topology	mixed traffic	(partially) dedicated track	dedicated track
Station length	10 to 40 m	40 to 120 m	> 120 m
Capacity (PPHPD)	1,000 to 10,000	3,000 to 25,000	15,000 to 60,000
Bus/train length	10 to 40 m	20 to 120 m	80 to 120 m
Comm. average speed	20 to 25 km/h	20 to 35 km/h	35 to 40 km/h
Headway (peak hour)	5 min	2 min	1 min
Average station spacing	0.1 to 0.6 km	0.3 to 0.8 km	0.5 to 1.0 km

A QUESTÃO DA OFERTA FACE À DEMANDA

HORIZONTE DO PROJETO

ÍNDICES (tempo de viagem, headway, velocidade)

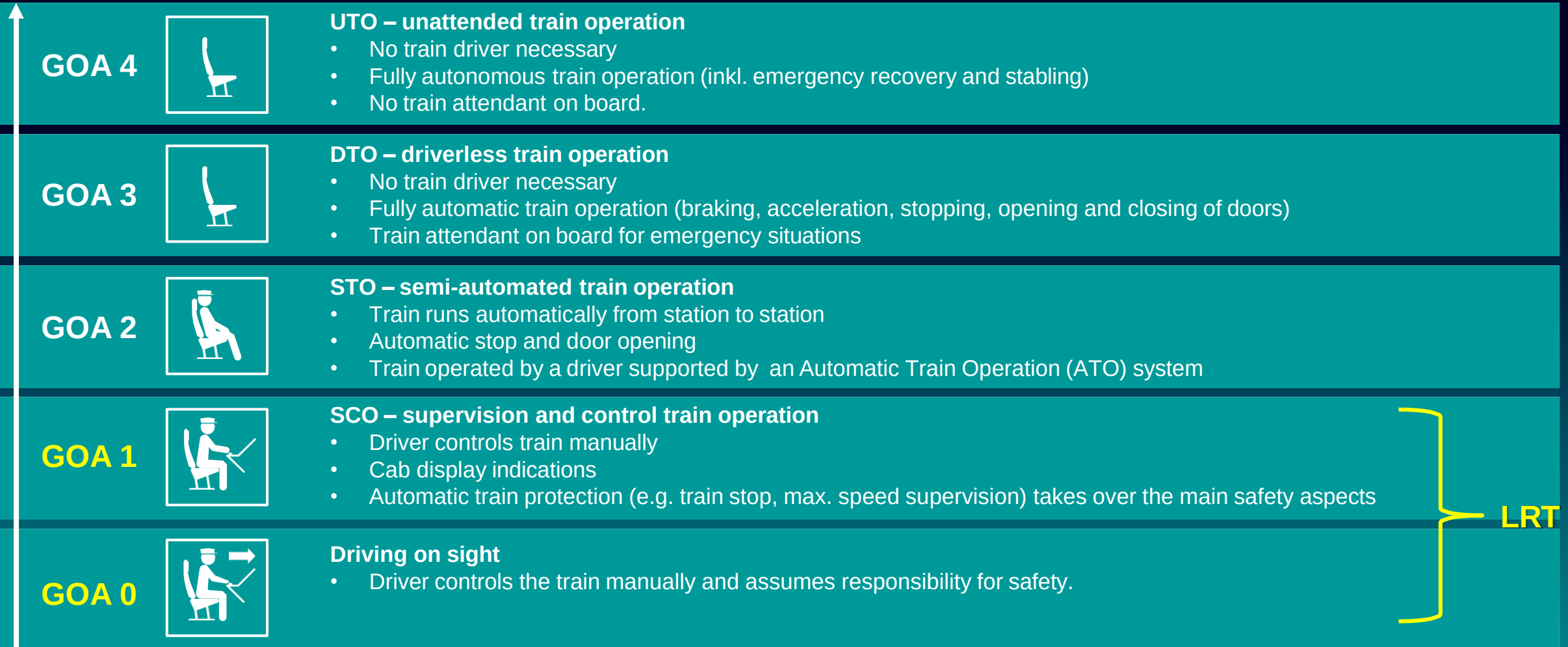
QUALIDADE a (acessibilidade, disponibilidade, conforto, lotação pass/m²)



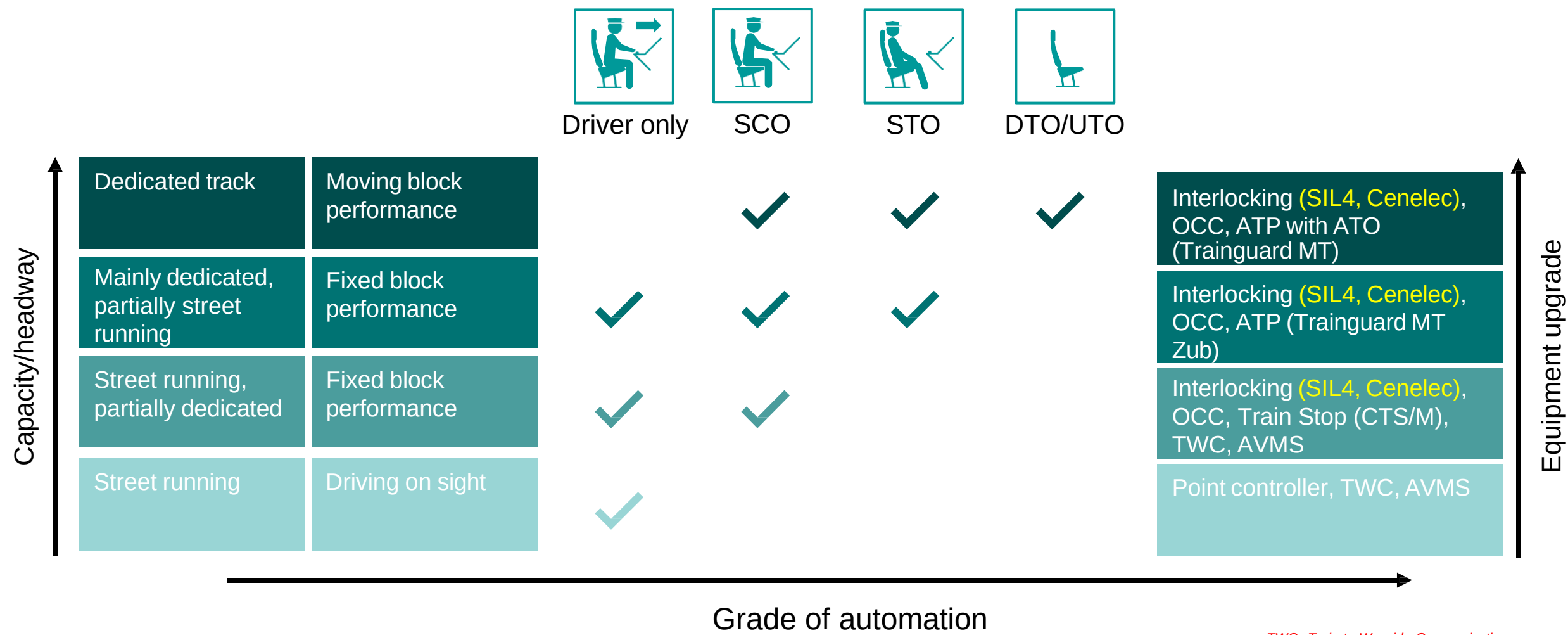
COMPARANDO
BRT x VLT x METRÔ LEVE x MONOTRILHO

	BRT	VLT	Metrô Leve	Monotrilho
VIA	Em superfície	Superfície ou elevado	Superfície, elevado ou subterrâneo	Elevado
Tecnologia	Dominada e fornecimento amplo e padronizado	Dominada e fornecimento amplo e padronizado	Dominada e fornecimento amplo e padronizado	De domínio e fornecimento restrito e não padronizado
Oferta pico (mil pass/h/sent)	10 a 30	15 a 35	25 a 45	15 a 35
Regularidade do transporte	Média	Média (se em superfície)	Alta	Alta
Segurança operacional	Média	Média	Elevada	Elevada
Custo de implantação (US\$)	15 a 20	20 a 30	40 a 80	40 a 80
Headway mínimo (seg)	40	40	80	80

Grades of operation and automation



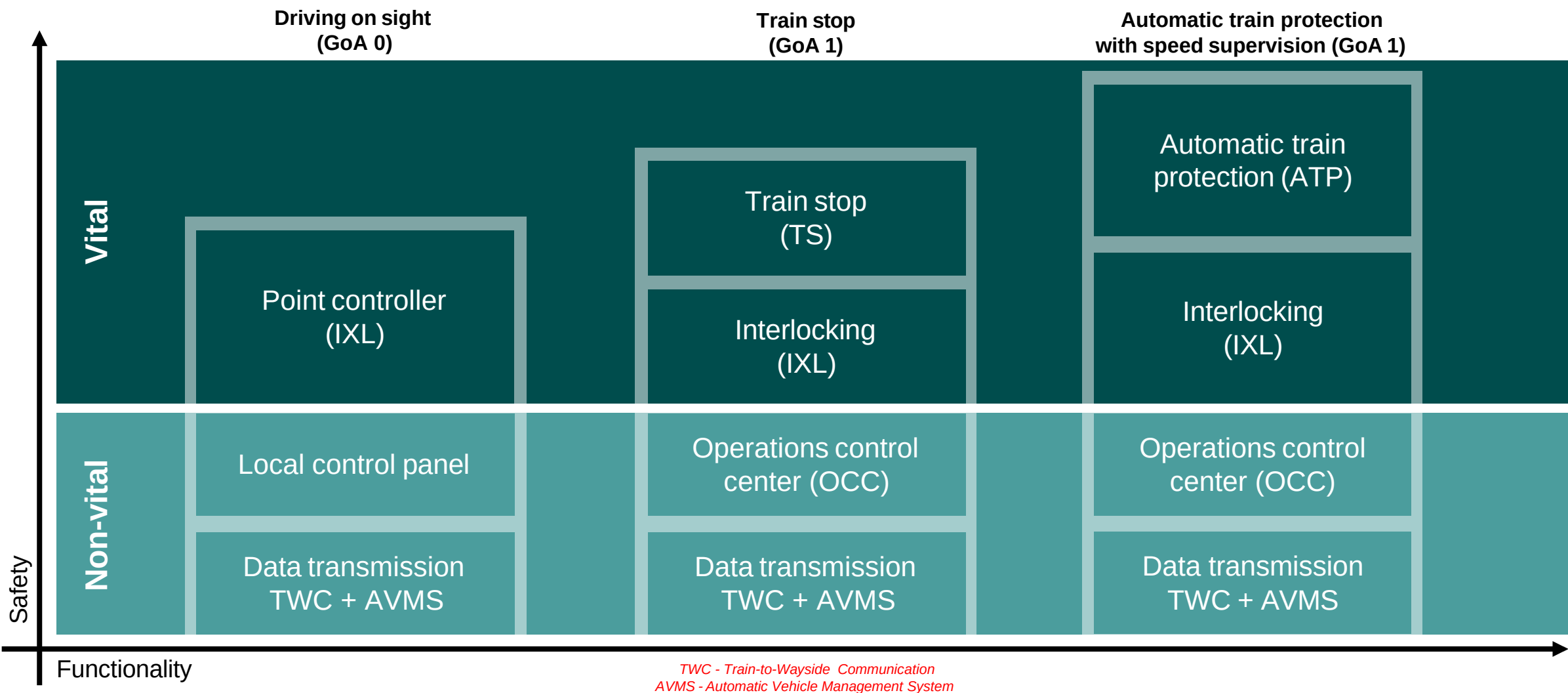
Level of operation and automation



TWC - Train-to-Wayside Communication
 AVMS - Automatic Vehicle Management System



Levels of light-rail transit solutions

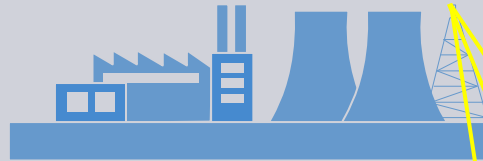


Eletrificação para transportes de massa

Arquitetura do Sistema

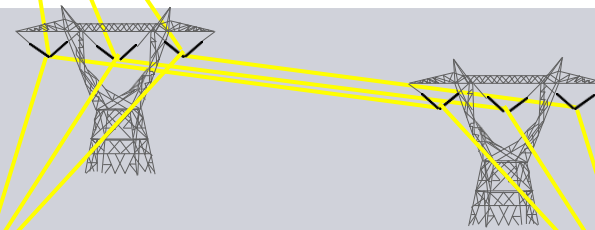
Geração

Usinas de Energia
Conversores



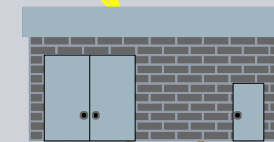
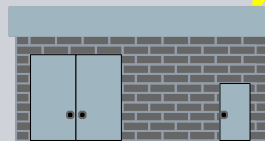
Transmissão

Rede de Alta Tensão
e Média Tensão



Distribuição

Subestações



Encaminhamento

Alimentação



Circuito de Retorno

Via/Trilho



Alimentação Elétrica em Corrente Contínua

Subestações

- Salas Técnicas em Túneis
- Prédios Pré-fabricados
- Container



Alimentação Elétrica em Corrente Contínua

Cubículos de Corrente Contínua

Desenvolvido especialmente para aplicação de VLT mais leve e compacto.
Retificador Integrado Sitras® CSG - Solução que se pretende aplicar em
Brasília.

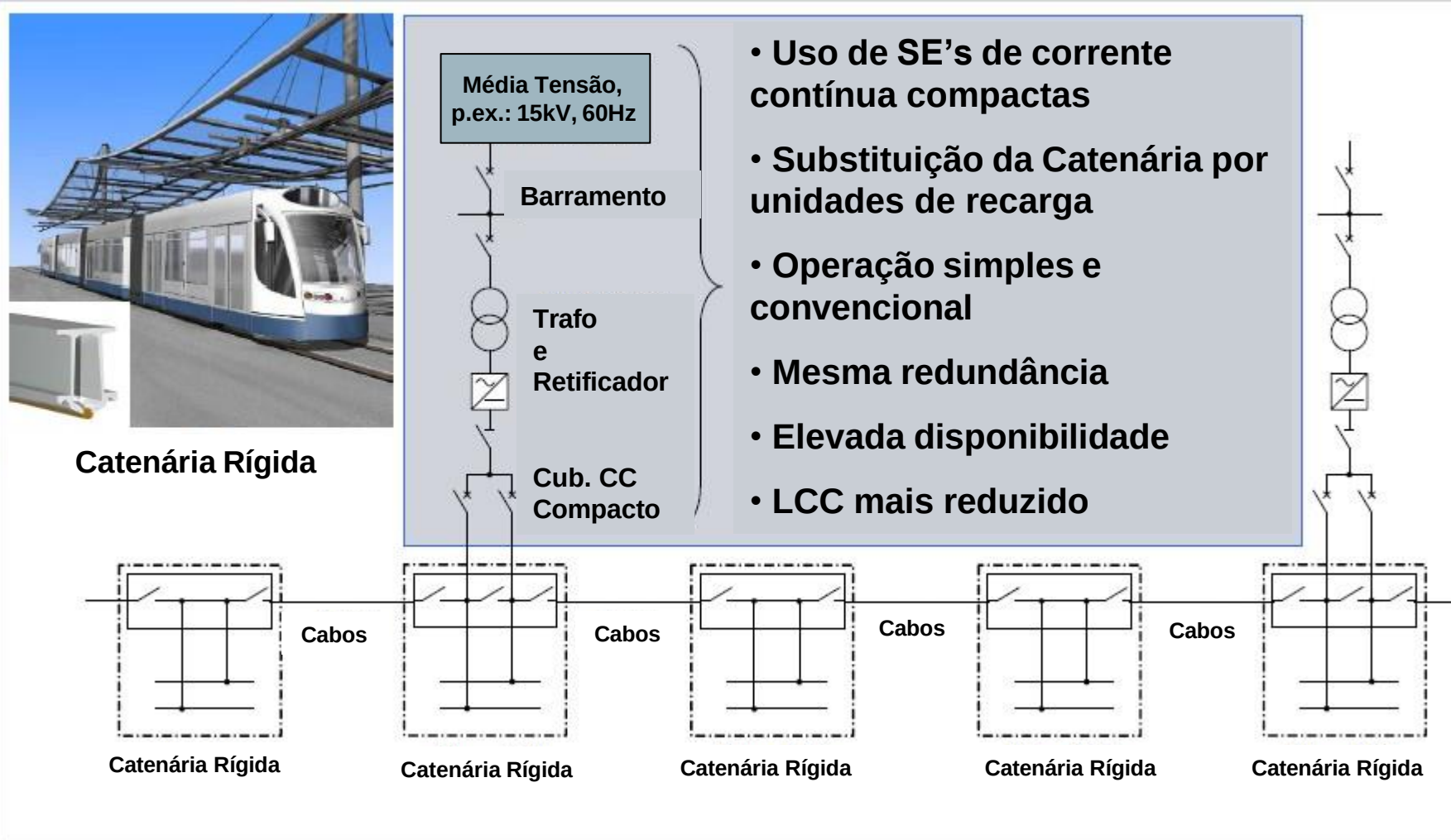


Cubículo CC
Sitras® DSG



Cubículo Compacto CC com
Retificador Integrado Sitras® CSG

Configuração:



Contato



Rezier Possidente

Business Development & Strategic Initiatives

Mobile: +55 11 99759-1922

rezier.possidente@siemens.com

[Siemens Mobility Website](#)

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See the stunning showcase of our state-of-the-art trains



@SiemensMobility

Get inspired by the latest updates and thought leadership pieces



Thank you!

¡Gracias!

Obrigado!



84 LOW-FLOOR TRAMS

Avenio Bremen, Germany

Siemens Mobility is one of the leading providers of integrated mobility solutions for urban areas as well as vehicles for mass transit and mainline traffic.

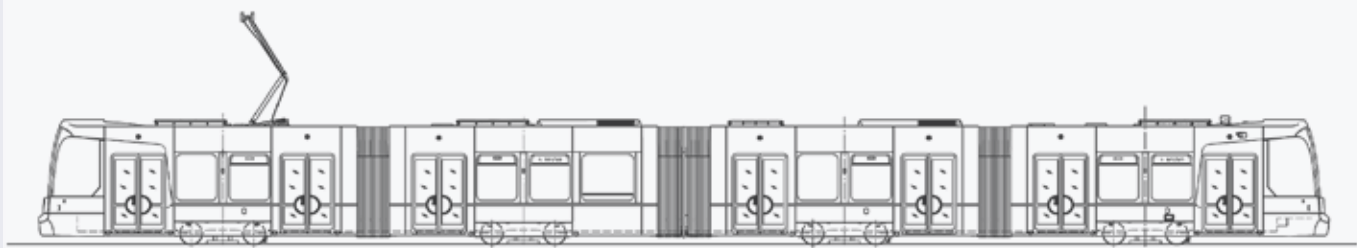
In June 2017, the German operator Bremer Straßenbahn AG (BSAG) ordered 67 Avenio® trams from Siemens. Only seven months later in January 2018, BSAG exercised the first option for ten new vehicles. The second option of seven Avenios followed in December 2021.

The four-car trains are being delivered since 2020. The Avenios are replacing the GT8N-series trams currently in service and will have the BSAG type designation GT8N-2.

With the front end painted the company's signature bright red and featuring the BSAG logo, the design references earlier Bremer Strassenbahn trams, clearly identifying the Avenios as new members of the BSAG fleet.

Technical data

Vehicle type/platform	100% low-floor articulated multiple unit Avenio
Vehicle configuration	4-section articulated train, unidirectional vehicle
Wheel arrangement	Bo'Bo'2'Bo'
Motor power rating	6 x 120 kW
Car body material	Steel, CDP-coated
Gauge	1,435 mm
Vehicle length over coupler	approx. 36,900 mm
Car width	2,650 mm
Entrance height/floor height above ToR	305 mm/445 mm above bogies
Passenger capacity with 4 passengers/m ²	250 including 70 seats/ 25 folding seats
Passenger doors	7 double doors with 1,300 mm clear width
Maximum operating speed	70 km/h
Power supply	DC 600/750 V (catenary voltage)



Technical properties/special features

- Excellent passenger comfort thanks to open, bright interior design with seats and handrails optimally designed according to ergonomic criteria; passengers can choose between upholstered and genuine wood seats
- Air-conditioning for passenger area and driver's cab and optimized running characteristics with three suspension stages
- Convenient access for passengers thanks to eight large multifunctional areas for strollers, walkers, and two wheelchairs
- Speedy boarding and alighting thanks to wide doors (seven double doors, 1,300 mm clear width)
- Weight-optimized vehicle design and maximized passenger capacity ensure compliance with limited axle load in existing network and reduced energy consumption
- Improved running characteristics, thanks to longitudinally arranged drives in the bogies and mechanical coupling of the wheels in longitudinal direction, minimal unsprung masses, and optimized bogie-to-car-body coupling
- Highest safety thanks to four independent brake systems
- Electro-dynamic brakes to provide comfortable and smooth braking to standstill and low brake wear
- Redundant design of traction equipment provides maximum reliability and failsafe performance (three IGBT pulse inverters, three SIBAS® 32C traction control units)
- The vehicles are all equipped with the Siemens Tram Assistant, which actively supports the driver in avoiding collisions, thereby increasing safety and reducing repair costs.



Spacious corridors and a clear layout ensure optimal passenger flow.



The bright, multifunctional interior design and the unique seat design guarantee a pleasant ride.



A modern design and multifunctional areas ensure optimal demand-oriented use of space.

Published by
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TH S62-240226 0724

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SIEMENS



29 LOW-FLOOR TRAMS

Avenio Copenhagen, Denmark

Siemens Mobility is one of the world's leading suppliers of integrated mobility solutions for urban areas and of vehicles for local, regional, and main-line transportation.

In February 2018, Hovedstadens Letbane (The Greater Copenhagen Light Rail) ordered 29 (27 of the Basis, 2 of the Options) four-car trams of the Avenio type from Siemens Mobility. The contract includes options for up to 30 vehicles. These new low-floor streetcars will serve one of three complete new light rail systems in Denmark.

Start of Passenger Operation is scheduled for 2025. In addition to the trams, the Siemens scope of supply includes railway electrification, signaling and communication technology as well as workshop equipment and the complete Project Management and System Integration. Furthermore, Siemens will carry out maintenance over a period of 15 years.

The double-track line is located between the towns of Lyngby in the north and Ishøj in the south of Copenhagen, having a length of 28 kilometres and includes 29 stops. The route runs along the Motorring 3 motorway and is planned to replace a bus route. The tramway is a building block on Copenhagen's path to becoming the world's first CO₂-neutral capital by 2025.

Technical Data

Vehicle type/platform	100% low-floor single-articulated tram vehicle Avenio
Configuration	4-car tram, for bi-directional operation
Wheel arrangement	Bo' 2' Bo' Bo'
Car body material	Steel
Length	36,900 mm
Width	2,650 mm
Entrance height	350 mm above top of rail
Motor power rating	6 x 100 kW
Power supply	750 V DC
Maximum speed	70 km/h
Track gauge	1,435 mm
Capacity (4 pers./m ²)	258 including 64 seats
Tare weight	approx. 48 t



Technical features/highlights

- A high-performance air conditioning system and ceiling light design enhance the passenger experience.
- Modern energy-saving LCD passenger information screens allow passengers to access up to date information.
- Excellent traction, acceleration and braking values supported by a fully aligned wheel/rail interface design towards the track profiles of the Network.
- Electro-dynamic brakes enable recuperation and provide smooth and comfortable stopping to standstill.
- Excellent running characteristics and low wheel-rail wear thanks to longitudinally installed drives in the bogies with mechanical coupling of the wheels in the longitudinal direction, small unsprung masses, and proven bogie connection to the car body.
- The interior and exterior design reflecting Hovedstadens Letbane green modern corporate design in a multitude of details, combining the company's strategy towards an ecofriendly future.
- Four multifunctional areas, which are all designed as full wheelchair spaces, ensure optimal demand-oriented space utilization.
- An Inductive Hearing Loop System to assist the hearing impaired.
- Compliant with the latest safety and security standards (including IT security, fire protection).
- Excellent Acoustic Performance regarding both interior and exterior noise levels.
- The driver assistance system "Siemens Tram Assistant" actively supports the driver to avoid collisions, thus improving safety and reducing repair costs



The ergonomic driver's cab provides a good overall view for safe operation.



Bright interior and unique seat design guarantee a pleasant ride.



Spacious boarding areas offer passengers a unique riding experience.

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SIEMENS



103 LOW-FLOOR TRAMS

Avenio Munich, Germany

In 2015, the SWM (Munich municipal utility provider) and the SWM subsidiary MVG (Munich Transport Association) ordered an additional 22 Avenio trams from Siemens. They will supplement the eight trams of the same type which have already been running for passenger service since 2014. A further order for 73 four-car trams was placed in June 2019. That means SWM still has an option for another 51 new units, which it can order in line with requirements.

The order from 2015 includes nine two-car trains, nine three-car trains and four four-car trains. The two-car and three-car units can be coupled to double-traction trains – the longest trams ever used in Munich at around 48 meters. An additional highlight with these trains is fully automatic coupling.

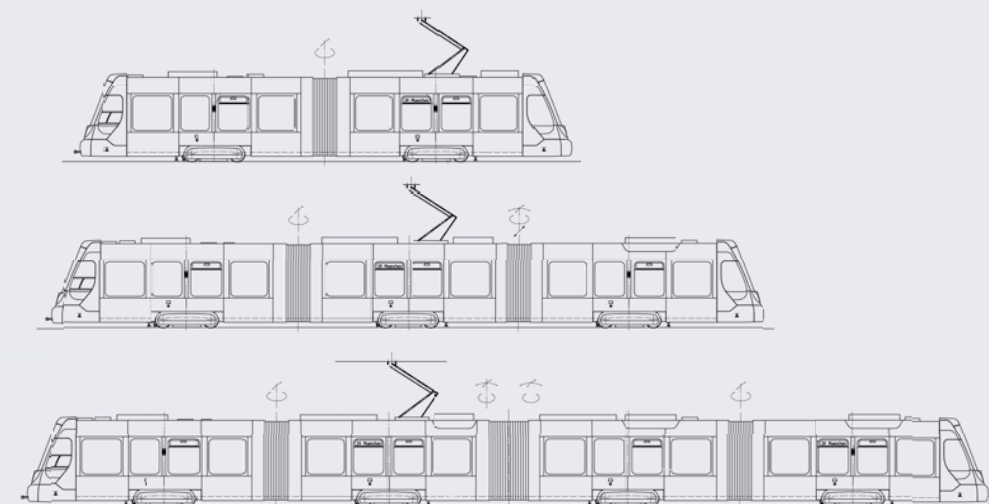
In this configuration they can accommodate around 260 passengers. The four new four-car Avenios correspond to the eight Avenios already in operation in terms of their length and capacity.

The 73 four-car trains ordered in 2019 making up the first option each provide space for about 216 passengers. Delivery of the first trains in this option is scheduled for 2021 to 2027.

Technical data

Vehicle type/ platform	100% low floor single-articulated tram vehicle Avenio				
Configuration	9 pieces 2-car	9 pieces 3-car	8 pieces 4-car	4 pieces 4-car	73 pieces 4-car
	for unidirectional operation				
Wheel arrangement	A1' Bo	2' Bo' Bo'	2' Bo' Bo' Bo'		Bo' 2' Bo' Bo'
Car body material	Steel				
Length	19,069 mm	27,699 mm	36,850 mm		
Width	2,300 mm				
Entrance height/ floor height	300 mm Entrance height/floor height				
Motor power rating	2 x 60 kW + 2 x 120 kW	4 x 120 kW	6 x 120 kW		
Power supply	DC 750 V				
Maximum speed	70 km/h				
Track gauge	1,435 mm				
Capacity (4 P/m²)	103 incl. 33 seats	157 incl. 51 seats	215 incl. 65 seats	219 incl. 60 seats	216 incl. 69 seats
Tare weight	approx. 24 t	approx. 35 t	approx. 45 t		

SIEMENS



Technical features/highlights

- The latest 73 vehicles ordered will all be equipped with the Siemens Tram Assistant, which actively supports the driver in avoiding collisions, thereby increasing safety and reducing repair costs.
- The new Avenio for Munich is the first Siemens tram equipped with RFID (radio-frequency identification) tags, which means operators can automatically track components equipped with these tags throughout their entire lifetime.
- A large number of doors enables fast boarding and exiting.
- The vehicles have a redundant auxiliary power supply system that ensures the continued power supply to the auxiliary systems in the event of an inverter or battery charger failure.
- The automatic coupling on the two and three-car units allows the formation of a train set.
- One vehicle in this option will be fitted with a hybrid energy storage system, and the others will be equipped to accommodate such a system in the future.



Spacious boarding areas improve the passenger flow



The bright, multifunctional interior design and the unique seat design guarantee a pleasant ride.



A wheelchair lift enables passengers with reduced mobility to board the train without barriers, even from street level.

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26 LOW-FLOOR TRAMS

Avenio GTA8 Nuremberg, Germany

Siemens Mobility is one of the world's leading suppliers of integrated mobility solutions for urban areas and of vehicles for local, regional, and main-line transportation.

The VAG Verkehrs-Aktiengesellschaft Nuremberg ordered 26 four-car trams of the Avenio type from Siemens Mobility. The contract includes options for up to 87 additional vehicles. These new low-floor streetcars are intended to strengthen VAG's service offering and for potential new lines. The Avenios have been beautifying Nuremberg's cityscape since 2023.

The four-car Avenio streetcars will successively take up passenger service on the Nuremberg tramway network, which has seven lines and covers an operating length of approximately 38 km.

Technical data

Vehicle type/ platform	GTA8/100% low-floor single-articulated tram vehicle Avenio
Configuration	4-car tram for unidirectional operation
Wheel arrangement	2' Bo' Bo' Bo'
Car body material	Steel
Length	36,850 mm
Width	2,300 mm
Entrance height/floor height	300 mm above bogies
Motor power rating	6 x 100 kW
Power supply	DC 600 V/750 V
Maximum speed	70 km/h
Track gauge	1,435 mm
Capacity (4 pers./m ²)	218 including 62 seats
Tare weight	approximately 45 t



Technical features/highlights

- A high-performance air conditioning system and an innovative LED ceiling light design enhance the passenger experience.
- Modern energy-saving LCD passenger information screens and Internet provided via WLAN allow passengers to access up-to-date information and USB charging sockets complete the picture.
- With its three powered bogies, the Avenio Nuremberg has excellent traction and high acceleration values for VAG's demanding and sometimes "mountainous" route profile.
- The unique VAG seat design and the extra-wide seats increase passenger comfort.
- The interior and exterior design reflect the new VAG corporate design in a multitude of details, combining the company's modernization strategy with a sense of home and tradition.
- Intensive coordination with disabled rights organizations took place during the design phase. This made it possible to achieve the greatest possible usability of the tram for passengers with reduced mobility.
- Improved running characteristics and low wheel-rail wear thanks to longitudinally installed drives in the bogies with mechanical coupling of the wheels in the longitudinal direction, small unsprung masses, and proven bogie connection to the car body
- Compliant with the latest security standards (including IT security, fire protection).
- Electro-dynamic brakes provide smooth and comfortable stopping to standstill.



Spacious boarding areas improve the passenger flow.



Multifunctional areas ensure optimal demand-oriented use of space.



The bright, multifunctional interior design and the unique seat design guarantee a pleasant ride.

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SIEMENS

Tram References

Avenio Education City – Doha, Qatar



Project data	
Year of construction	2014–2015
Number of vehicles	19 trains
Scope of delivery	100%, complete vehicle
Special features	Adaptation to climatic conditions (sun / heat, dust / sand); Vehicle for catenary-free operation (ultra caps)

Vehicle data	
Vehicle type / Platform	100% low floor single-articulated tram vehicle / Avenio
Configuration	3-car (bi-directional operation)
Wheel arrangement	Bo' 2' Bo'
Car body material	Steel
Length (over coupling)	27,700 mm
Width	2,550 mm
Entrance height / floor height	350 mm / 435 mm above bogies
Motor power rating	4 x 120 kW
Power supply	DC 750 V
Maximum speed	40 km/h
Track gauge	1,435 mm
Capacity (4 P/m²)	157, incl. 48 seats / 3 tip-up seats
Tare weight	approx. 45 to



Siemens Catenary Free Solution Hybrid Energy Storage System (HESS)

SIEMENS
Ingenuity for life

Capacitors

Capacitor units ensure highest performance and short charging times

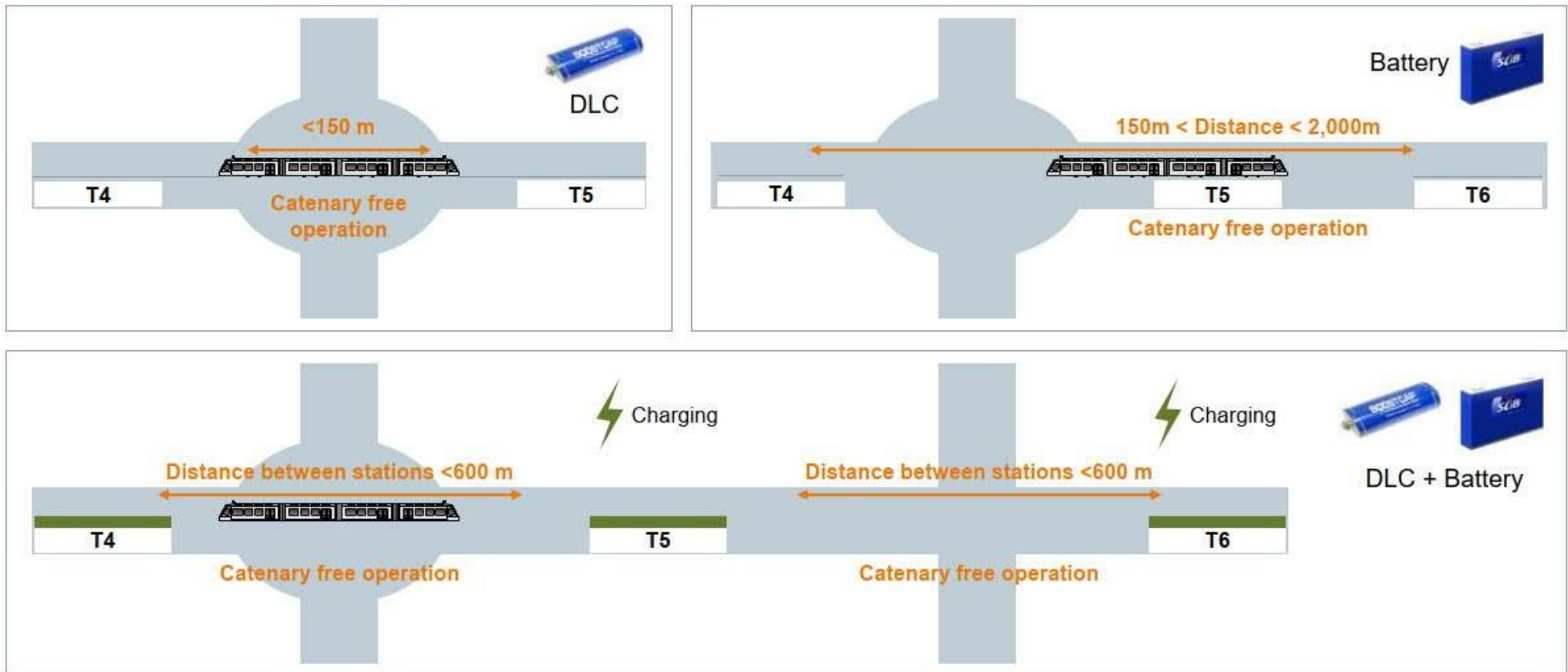


High performance batteries

Batteries provide highest energy capacity for unexpected stops and longer sections without catenary

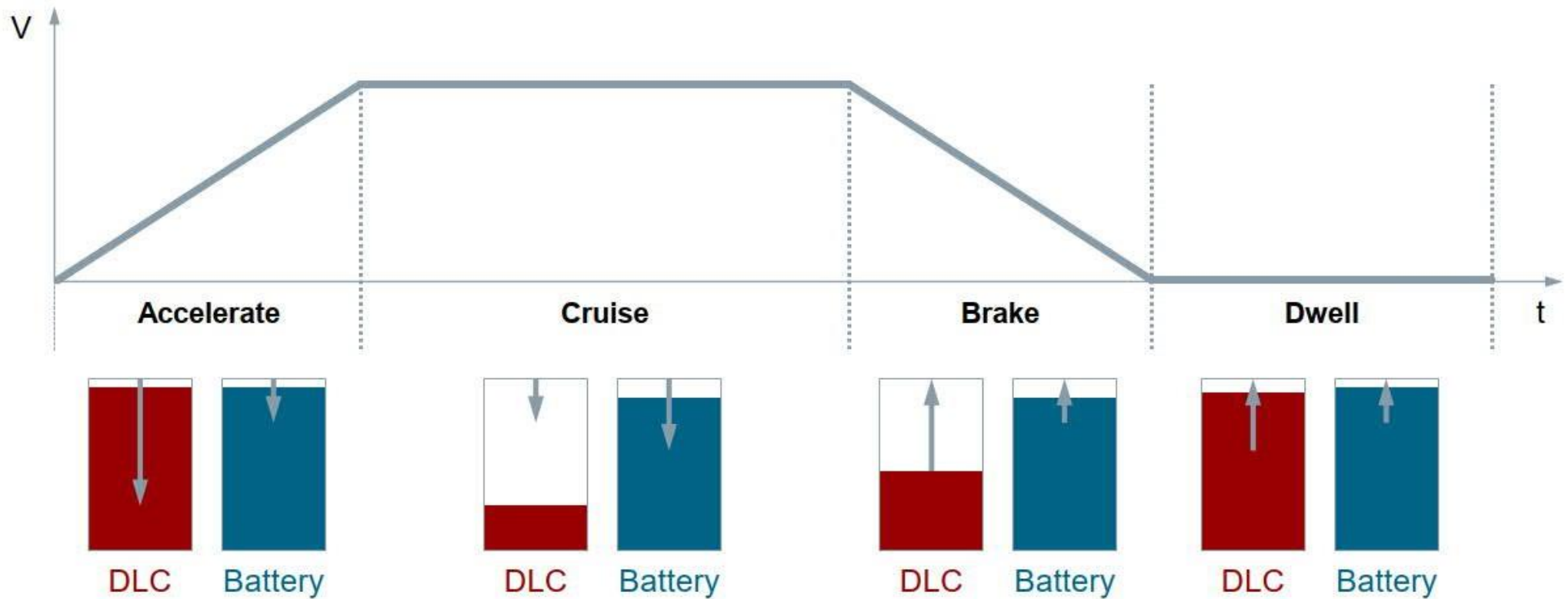


Siemens Catenary Free Solution Applications of the HESS



Siemens Catenary Free Solution How the HESS works

SIEMENS
Ingenuity for life



Siemens Catenary Free Solution

Benefits of an energy storage solution



Safety

- Enhanced safety, no danger by magnetic fields and touch voltages
- No impact on road construction and maintenance
- No influence by sand, water, flooding ...

Environmental

- Up to 25% energy savings
- Up to 25% lower CO2 emissions
- No additional weight > compensated through light and optimized vehicle construction

Maintenance

- Low operation costs
- Maintenance free technology / no complex switching technology
- Easy to extend and upgrade

Market

- Participation in world future technology
- Open systems, i.e., no dependency on one supplier

Siemens Catenary Free Solution Distance

System	Catenary Free Distance			Technology
	< 0.5 mile	< 1 mile	> 1 mile	
 Lisbon - SIEMENS			◆	Battery & Super Capacitors
 Doha - SIEMENS	◆			Battery & Super Capacitors
 *Qatar - SIEMENS			◆	Battery



A new range of trams

Enhanced passenger comfort, robust structure and the versatility to adapt to the needs of any operator are the hallmarks of the Tramlink.

GENERAL CHARACTERISTICS
Option of two traction units
Body made of high-strength stainless steel
Glued external plating for easy repair
Optional rear view camera
Large glazed surface
Complies with EN 15227 for crashworthiness
Regenerative braking with energy storage and saving systems
Water-cooled traction motors
Sanding systems in all motorized axles
Wheel flange lubrication system (time, distance and location can be scheduled)
Anti-skid and anti-slip protection systems
Advanced passenger information systems
Independent HVAC in driver cabs and passenger areas
CCTV system
People counting/fire detection systems
All bogies with high-duty electromagnetic track brakes
Possibility to install rear view cameras
Maximum floor gradient 5%
Customized frontal design and interior layout

TRAMLINK FAMILY	
Power supply voltage	750 V DC (+20-30%)
Minimum track radius (normal operation/depot)	18 m / 17 m
Interconnecting aisle	Width >1,230 mm
Low floor	100%
PERFORMANCE	
Maximum speed	70 km/h
Acceleration (up to 35 km/h)	1.2 m/s ²
Normal deceleration	1.2 m/s ²
Emergency deceleration	2 m/s ²
Minimum deceleration with safety brake	1 m/s ²
Maximum gradient	8%
Rated output	4 x 105 kW (V3)
TRAMLINK BOGIES	
Gauge	1,000 mm // 1,435 mm
Wheelbase	1760 mm
Wheel diameter (new / worn)	600 mm // 520 mm
Primary suspension	Rubber-metal springs
Secondary suspension	Conventional wheelsets
TRAMLINK DIMENSIONS (basic V3 configuration)	
Number of cars	5
Overall length	28 to 35 m
Height (pantograph folded)	3,450 mm
Width	2.0 m // 2.40 m // 2.65 m
Floor height	360 mm // 450 mm
Access height	315 mm
Doors each side (Tramlink, bidirectional)	4 double: 2,000 x 1,300mm 2 single: 2,000 x 800 mm
TRAMLINK CAPACITIES (standard V3, 2.65 m)	
Seats	54 + 6 folding
Standing (4 passengers / m ²)	182
Multipurpose areas	2
WEIGHT (standard V3, 2.65 m)	
Car weight (empty)	41,500 kg ± 3% (basic configuration)
Rated payload (4 p/m ²)	55,000 kg

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Polígono Industrial del Mediterráneo
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vossloh
Rail Vehicles

Tramlink Efficient mobility



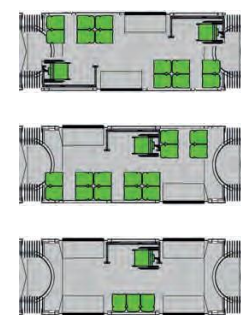
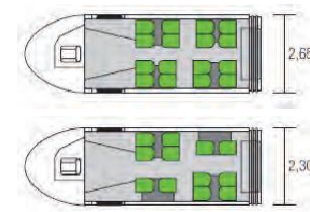
With the guarantee of more than a century

... of experience from contributing to innovative solutions in rail transport, our goal is to design and develop technologically advanced, high-performance and environment-friendly rolling stock that allows comfortable, fast, safe and accessible transport tailored to the specific needs of operators and passengers alike.



A comfortable model

Vossloh's experience in the design, integration and manufacture of complete vehicles combined with vast technological knowledge in the development of high-performance bogies, assure the best ride dynamics and greater use of interior space without steps or ramps, allowing up to 16 seats above the bogies and passengers a safe and comfortable journey.



A sustainable and ecological vehicle

Tramlink is engineered to have the longest possible life-cycle with the lowest maintenance costs. The energy recovery and storage systems as well as the use of stainless steel with a high elastic limit, minimize your operating costs while ensuring compliance with EN 15227 requirements for crashworthiness.

A versatile vehicle

With configurations of 3, 5, 7 or 9 articulated cars, with lengths ranging between 21 and 57 meters. Adaptable to metric and standard gauges, and allowing width options of 2.30 to 2.65 meters. A low-floor tram with customizable design.

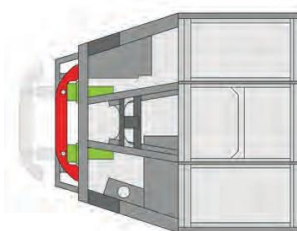
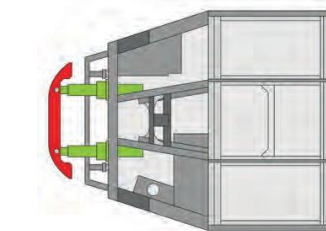
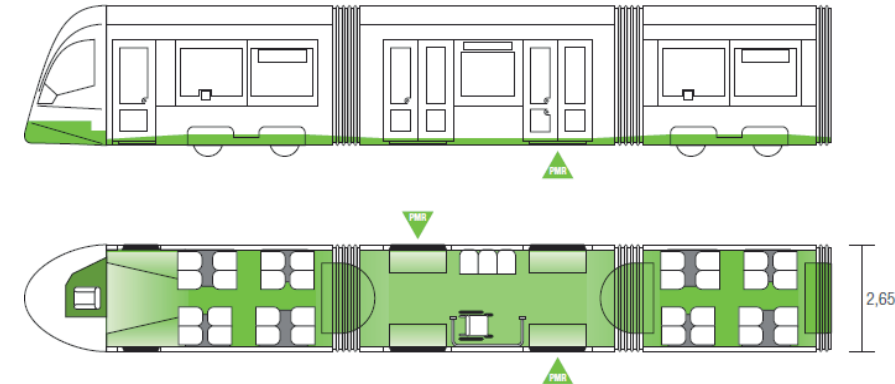
Tramlink

TRAMLINK CONFIGURATIONS	LENGTHS
V2 + 2 bogies + 3 modules	21 m to 27 m
V3 + 3 bogies + 5 modules	28 m to 35 m
V4 + 4 bogies + 7 modules	37 m to 44 m
V5 + 5 bogies + 9 modules	46 m to 57 m



An accessible vehicle

100% low floor and fully accessible for people with limited mobility. Multipurpose areas.



Marcopolo
RAIL

Apresentação Institucional



Alinhada com o propósito de melhorar a experiência de vida por meio da mobilidade, a **Marcopolo Rail** é uma unidade de negócios do Grupo Marcopolo, especializada no desenvolvimento e produção de modais ferroviários.



Portfólio de Atuação



PROSPER Multiple Units
PROSPER TRAM



CARROS de Passageiros



CARBODY Manufacturing



MODERNIZAÇÃO
& Manutenção

PROSPER

Multiple Units



Versões Turismo, Intercidades e Urbana

Produto versátil, com baixos custos de implantação e operacionais, aliados a um design moderno e confortável.

- Bidirecional;
- Embarque em Plataforma 1,10m;
- Bitolas Métrica, Standard ou Larga;
- Janelas e Portas de emergência;
- Equipamento de ar condicionado com aquecimento e refrigeração
- Gama Completa de Opcionais;

-DMU (Diesel Multiple Units)
-HYBRID (Sob Consulta)





Tecnologia

- Atendimento à normas internacionais ferroviárias;
- Sistema de ar-condicionado tipo monobloco;
- Truques com suspensão a ar secundária;
- Ampla área envidraçada;
- Cabine com envoltório acional ergonômico;
- Alta capacidade de customização;
- Bidirecional

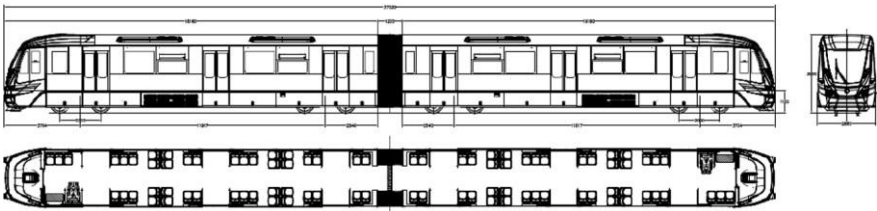


Powerpack diesel-hidromecânico:
Composto de motor diesel horizontal de 390 kw @ 1800 rpm com gerador elétrico integrado, transmissão automática de 4 velocidades e caixa de reversão do sentido de marcha.

- VANTAGENS:
- FACILIDADE DE MANUTENÇÃO E REPARO
 - MENOR RISCO QUANDO COMPARADO COM EQUIPAMENTOS DE ALTA TENSÃO
 - BAIXO CUSTO LCC – LIFE CYCLE COST



2 carros - 360 passageiros



3 carros - 560 passageiros



4 carros - 760 passageiros



INTERIORISMO: Os layouts são desenvolvidos conforme a aplicação, visando maior conforto do passageiro e maior aproveitamento do salão.



MADE IN BRAZIL

Dados Técnicos
(DMU – Diesel Multiple Units)

Composição da Unidade Operacional (VLT) - carros	2	3	4
Configuração de motorização dos carros MC = Motor Car \ TC = Trailer Car	MC+MC	MC+TC+MC	MC+TC+TC+MC
Bitola da via (mm)	1000 (1435 / 1600 sob consulta)		
Movimentação	bidirecional		
Número de cabines por VLT	2 (duas)		
Material das janelas	Policarbonato / Vidro		
Material de balaústres e pega-mão	Aço inoxidável		
Comprimento aproximado de cada carro	18.000 mm		
Largura externa máxima	2.900 mm		
Altura máxima do veículo	3.900 mm		
Altura do piso ao boleto do trilho na região das portas	1.100 mm		
Tipo de motorização para tração	Diesel-hidráulica		
Peso máximo por eixo	13000 Kgf		
Largura do vão das portas (versão urbana)	>=1200 mm		
Número de vãos de portas por lado do carro (versão urbana)	3 (três)		
Circulação interna entre carros	Gangway		
Raio mínimo de curva horizontal	90 m		
Raio mínimo de curva vertical	500 m		
Rampa máxima	3%		
Capacidade total de pass. por VLT (6 pass/m²)	360	560	760
Capacidade passageiros sentados por VLT (6 pass/m²)	84	128	172
Velocidade máxima operacional	80 Km/h		
Aceleração na partida	0,95 m/s²	0,70 m/s²	0,55 m/s²
Desaceleração em serviço máximo	0,8 + 10% - 5% m/s²		
Desaceleração em emergência	1,0 ± 10% m/s²		
Nível máximo de solavanco	1,0 m/s³		



Tecnologia

- Atendimento à normas internacionais ferroviárias;
- Sistema de ar-condicionado tipo monobloco;
- Truques com suspensão a ar secundária;
- Ampla área envidraçada;
- Cabine com envoltório acional ergonômico;
- Alta capacidade de customização;
- Bidirecional

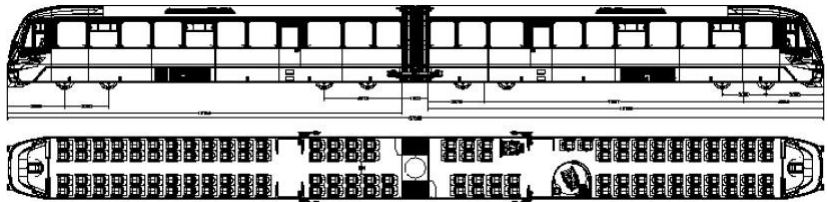


Powerpack diesel-hidromecânico:
Composto de motor diesel horizontal de 390 kw
@ 1800 rpm com gerador elétrico integrado,
transmissão automática de 4 velocidades e caixa
de reversão do sentido de marcha.

- VANTAGENS:
- FACILIDADE DE MANUTENÇÃO E REPARO
 - MENOR RISCO QUANDO COMPARADO COM EQUIPAMENTOS DE ALTA TENSÃO
 - BAIXO CUSTO LCC – LIFE CYCLE COST



2 carros – 122 passageiros



3 carros – 180 passageiros



4 carros – 248 passageiros



INTERIORISMO: Os layouts são desenvolvidos conforme a aplicação, visando maior conforto do passageiro e maior aproveitamento do salão.



MADE IN BRAZIL

Dados Técnicos (DMU – Diesel Multiple Units)

Composição da Unidade Operacional (VLT) - carros	2	3	4
Configuração de motorização dos carros MC = Motor Car \ TC = Trailer Car	MC+MC	MC+TC+MC	MC+TC+TC+MC
Bitola da via (mm)	1000 (1435 / 1600 sob consulta)		
Movimentação	bidirecional		
Número de cabines por VLT	2 (duas)		
Material das janelas	Policarbonato / Vidro		
Comprimento aproximado de cada carro	18.000 mm		
Largura externa máxima	2.900 mm		
Altura máxima do veículo	3.900 mm		
Altura do piso ao boleto do trilho na região das portas	1.100 mm		
Tipo de motorização para tração	Diesel-hidráulica		
Peso máximo por eixo	13000 Kgf		
Largura do vão das portas (versão intercidades)	<=1.000 mm		
Número de vãos de portas por lado do carro	1 (um)		
Circulação interna entre carros	Gangway		
Raio mínimo de curva horizontal	90 m		
Raio mínimo de curva vertical	500 m		
Rampa máxima	3%		
Capacidade total de pass. por VLT	122+1PCD	180+2PCD	248+2PCD
Capacidade passageiros sentados por VLT	122	180	248
Velocidade máxima operacional	80 Km/h		
Aceleração na partida	0,95 m/s ²	0,70 m/s ²	0,55 m/s ²
Desaceleração em serviço máximo	0,8 + 10% - 5% m/s ²		
Desaceleração em emergência	1,0 ± 10% m/s ²		
Nível máximo de solavanco	1,0 m/s ³		

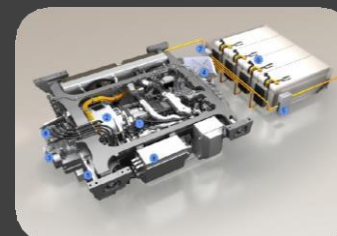
PROSPER HYBRID



VERSÃO HMU (HYBRID MULTIPLE UNITS)

Produto versátil, com baixos custos de implantação e operacionais, aliados a um design moderno e confortável.

- Bidirecional;
- Embarque em Plataforma 1,10m;
- Bitolas Métrica, Standard ou Larga;
- Janelas e Portas de emergência;
- Equipamento de ar condicionado com aquecimento e refrigeração
- Gama Completa de Opcionais;



Powerpack Híbrido

- Motor Diesel
- Motor elétrico de tração - gerador
- Caixa de Cambio
- Exaustor após tratamento de emissões
- Tanque de AdBlue®
- Baterias de Lithium-ion
- Conversor de Tração
- Sistema de controle



PROSPER

HYBRID

Marcopolo **RAIL**

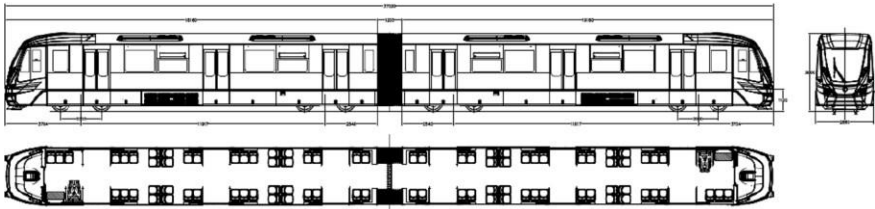


INTERIORISMO: Os layouts são desenvolvidos conforme a aplicação, visando maior conforto do passageiro e maior aproveitamento do salão.

Tecnologia

- Atendimento à normas internacionais ferroviárias;
- Sistema de ar-condicionado tipo monobloco;
- Truques com suspensão a ar secundária;
- Ampla área envidraçada;
- Cabine com envoltório acional ergonômico;
- Alta capacidade de customização;
- Bidirecional

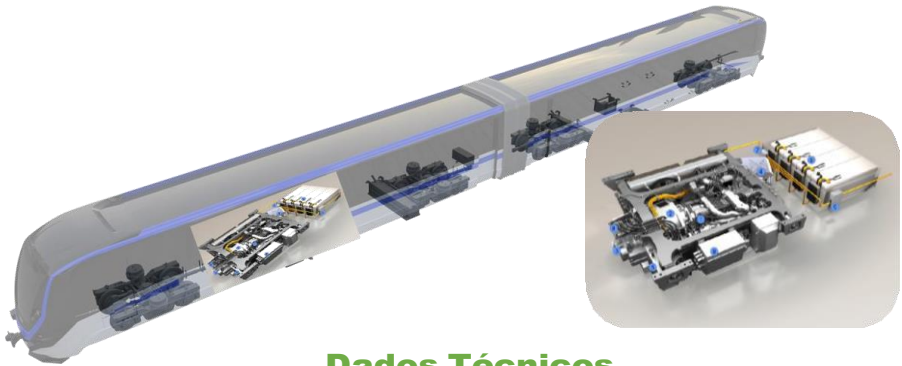
2 carros - 360 passageiros



3 carros - 560 passageiros



4 carros - 760 passageiros



Dados Técnicos

(HMU – HYBRID Multiple Units)

Composição da Unidade Operacional (VLT) - carros			
Bitola da via (mm)	1000 (1435 / 1600 sob consulta)		
Movimentação	bidirecional		
Número de cabines por VLT	2 (duas)		
Material das janelas	Policarbonato / Vidro		
Material de balaústres e pega-mão	Aço inoxidável		
Comprimento aproximado de cada carro	18.000 mm		
Largura externa máxima	2.900 mm		
Altura máxima do veículo	3.900 mm		
Altura do piso ao boleto do trilho na região das portas	1.100 mm		
Tipo de motorização para tração	DIESEL-ELÉTRICO (Com baterias)		
Peso máximo por eixo	13000 Kgf		
Largura do vão das portas (versão urbana)	>=1200 mm		
Número de vãos de portas por lateral(versão urbana)	3 (três)		
Circulação interna entre carros	Gangway		
Raio mínimo de curva horizontal	90 m		
Raio mínimo de curva vertical	500 m		
Rampa máxima	3%		
Capacidade total de pass. por VLT (6 pass/m²)	2 Carros: 360	3 Carros: 560	4 Carros: 760
Velocidade máxima operacional	80 Km/h		
Aceleração na partida	0,95 m/s²	0,70 m/s²	0,55 m/s²
Desaceleração em serviço máximo	0,8 + 10% - 5% m/s²		
Desaceleração em emergência	1,0 ± 10% m/s²		
Nível máximo de solavanco	1,0 m/s³		

PROSPER TRAM

100% Elétrico



Versatilidade e tecnologia conectadas com o que há de mais atual em Veículos Leves sobre Trilhos (TRAMs).

- Atendimento às normas internacionais ferroviárias;
- Sistema de ar-condicionado tipo monobloco;
- Ampla área envidraçada;
- Cabine com envoltório acional ergonômico;
- Alta capacidade de customização;
- 100% Elétrico (Catenária);



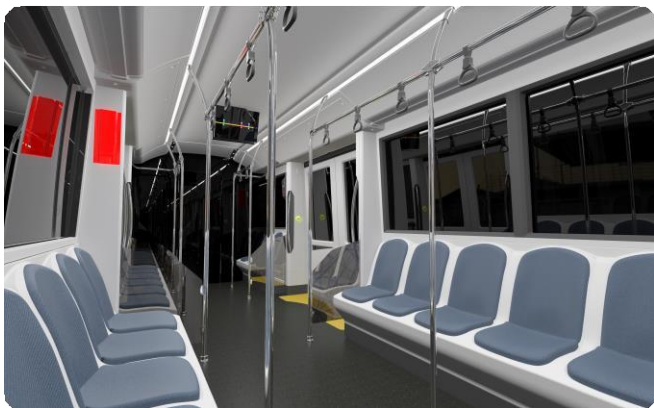
Marcopolo **RAIL**



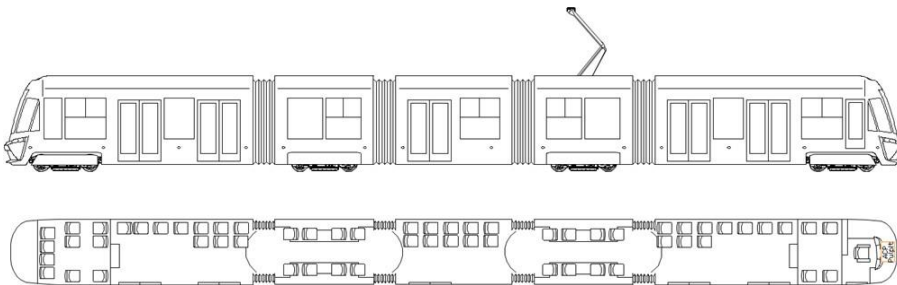
-Versatilidade e tecnologia conectadas com o que há de mais atual em Veículos Leves sobre Trilhos (TRAMs).

-Parcerias Estratégicas.

- Atendimento às normas internacionais ferroviárias;
- Sistema de ar-condicionado tipo monobloco;
- Ampla área envidraçada;
- Cabine com envoltório acional ergonômico;
- Alta capacidade de customização;
- 100% Elétrico (Catenária)



INTERIORISMO: Os layouts são desenvolvidos conforme a aplicação, visando maior conforto do passageiro e maior aproveitamento do salão.



Dados Técnicos (TRAM 100% Elétrico)

Composição da Unidade Operacional (VLT) - carros		Informações Técnicas
Bitola da via (mm)		1435 \ 1000
Movimentação		Bidirecional ou Unidirecional
Número de cabines por VLT		2 (duas) \ 1(Uma) Opcional
Número de CARROS por Composição		5
Comprimento da composição (metros)		32m
Largura externa máxima		2.400 mm
Altura máxima do veículo		3.700 mm
Altura do piso ao boleto do trilho na região das portas		355 mm
Tipo de motorização para tração / Tensão de alimentação		100% elétrico com catenária / 750 Vcc
Peso máximo por eixo		10000 Kgf
Largura do vão das portas		1300 mm
Número de vãos de portas por lado da composição		5
Circulação interna entre carros		Gangway
Raio mínimo de curva horizontal		25 metros
Rampa máxima		6%
Capacidade total de pass. por VLT (6 pass/m²)		280 PAX
Capacidade passageiros sentados por VLT		40 PAX
Velocidade máxima operacional		75 Km/h



**CARBODY
MANUFACTURING**
People Movers

A divisão CARBODY MANUFACTURING produz trens e projetos especiais, que atendem aos mais altos padrões internacionais de qualidade.

CARBODY PARA PEOPLE MOVERS:

- Design interno exclusivo de 150 a 450 passageiros;
- 8 portas laterais;
- Acessibilidade, segurança e sinalização interna conforme normas internacionais;
- Sistema de entretenimento e informação para passageiros;
- Integração de todos os subsistemas;



Marcopolo **RAIL**

CARBODY

Manufacturing

Tecnologia e design que garantem mais conforto, segurança e modernidade aos usuários e mais robustez e longo ciclo de vida do sistema.



CARBODY PARA PEOPLE MOVERS:

- Design interno exclusivo de 150 a 450 passageiros;
- 8 portas laterais;
- Ar condicionado para refrigeração, aquecimento e ventilação de emergência;
- Acessibilidade, segurança e sinalização interna conforme normas internacionais;
- Sistema de entretenimento e informação para passageiros.



Parceria Estratégica

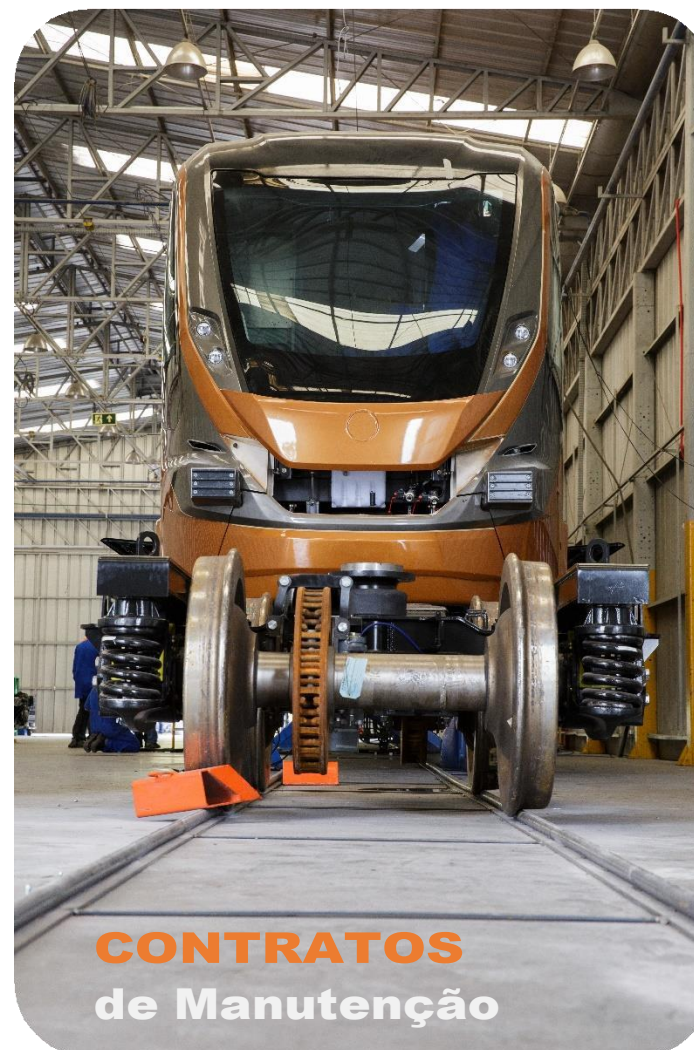


Marcopolo **RAIL**



MODERNIZAÇÃO & Reformas

- Projetos especiais para modernização \ reforma de trens;
- Alta capacidade de customização;
- Pós-vendas e assistência técnica em toda a América Latina;



CONTRATOS de Manutenção

- Contratos de Manutenção;
- Reparos de Acidentes;
- Peças de Reposição;
- Revisão;



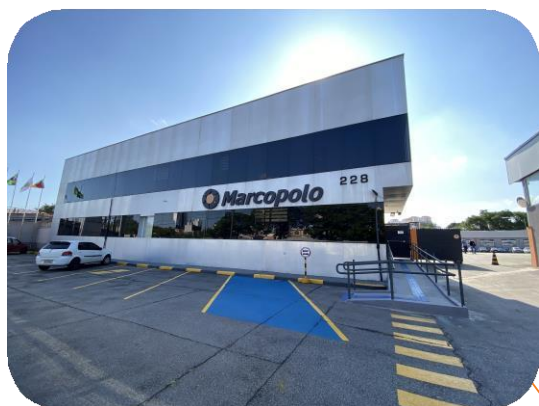
Marcopolo **RAIL**

Complexo Industrial Marcopolo
Caxias do Sul – RS - BRASIL

**Escritório
Corporativo**



**Planta Industrial
Ferroviária**



Escritório São Paulo

**Av. Pres. Tancredo Neves, 228 Vila
Nancy, São Paulo - SP**



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www.marcopolorail.com

Introduction of Hydrogen Tram and Roadmap



Hyundai-Rotem
Rolling Stock R&D Center

August, 2024



- Contents -

- 1. Why Hydrogen Fuel Cell Tram?**
- 2. Hyundai Rotem Hydrogen Tram**
- 3. Hydrogen Mobility Roadmap**
- 4. Hydrogen Infrastructure**

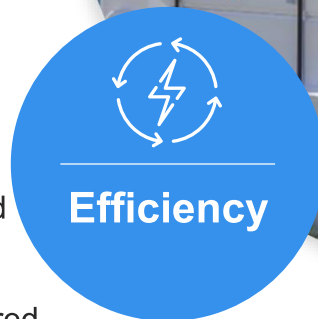
1. Why Hydrogen Fuel Cell Tram?

Advantage of Hydrogen Fuel Cell Train

- ✓ **Sustainable energy** source without any emission of air pollutants
- ✓ Most **abundant element** on universe and respond to growing energy demands
- ✓ **Renewable energy** to generate green hydrogen



- ✓ **No catenary** & related **substation**, power facilities.
- ✓ **Versatility for Line extension**
- ✓ Hydrogen **cost decrease** over time



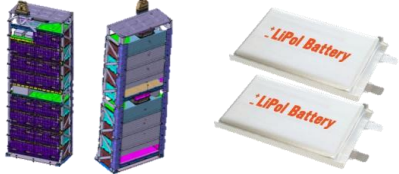
- ✓ Up to three times more **efficient** than internal combustion engines
- ✓ **Long cruising distance** further than battery-powered electric trains
- ✓ Quick refueling time compared to charging battery

- ✓ No greenhouse gas & **Air purification(99.99%)**
※ 31ton of air purification per day
- ✓ Hydrogen is **non-toxic** and disperses into the air when leaked
- ✓ No catenary to harm **urban aesthetic**



1. Why Hydrogen Fuel Cell Tram?

Competitiveness of Hydrogen Fuel Cell

Category	Battery Tram	Super-capacitor Tram	Hydrogen Fuel Cell Tram
Power Source			
Energy Density	Middle	Low	High
Running Distance	$\leq 10\text{km}$ (One-way)	$\leq 1\text{km}$ (Short distance between stations)	$\pm 150\text{ km}$ (suitable for multiple round-trips)
Charging Time	$\leq 1\text{ Hour}$ (Battery charging station)	30 Seconds (Charging via catenary at stations)	15 Minutes (Hydrogen Refuel station)
Operation Method	Non-catenary + catenary section	Non-catenary + catenary section	Non-catenary
Operation Facility	Battery Charging Station	Super capacitor charging facilities	Hydrogen Refuel station
Operation Purpose	Short Distance (less than 10km)	Between stations (less than 1km)	Non-limit (Long/short Distance)

1. Why Hydrogen Fuel Cell Tram?

Competitiveness of Hydrogen Fuel Cell

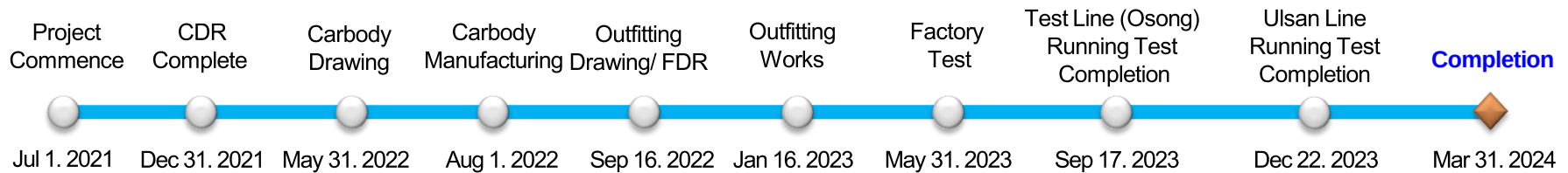
Category	Catenary System	Catenary-Free System			
	Overhead	3 rd Rail (APS)	Super Capacitor	Battery	Hydrogen Fuel Cell
Power Source	Overhead Catenary	Street-level Power Supply Rail	Rapid charging at Stations	Battery charging at Depot / Stations	Hydrogen charging at Refueling Station
Vehicle Image					
Running Distance	Unlimited	Unlimited	1km (single charge)	10km (single charge)	> 150km
Charging Time	-	-	30 Seconds (charges at stations)	> 1 hour	15 minutes
Operation Method	Catenary	Third Rail	Non-catenary + catenary section	Non-catenary + catenary section	Non-catenary
Basic Facilities (Requirement)	- Overhead Catenary - Substations / Power facilities	- Ground Power Supply Rail - Substations/Power facilities	- Overhead Catenary at stations - Substations/Power facilities	- Battery Charging Stations(Depot, station) - Substations	Hydrogen Refueling Station
Remarks		- Ground power facilities (BOX, 1 box per 22m) - Low maintainability of box due to high humidity and rain.			

Hydrogen fuel cell is the suitable solution for heavy duty train

2. Hyundai Rotem Hydrogen Tram

Demonstration Schedule

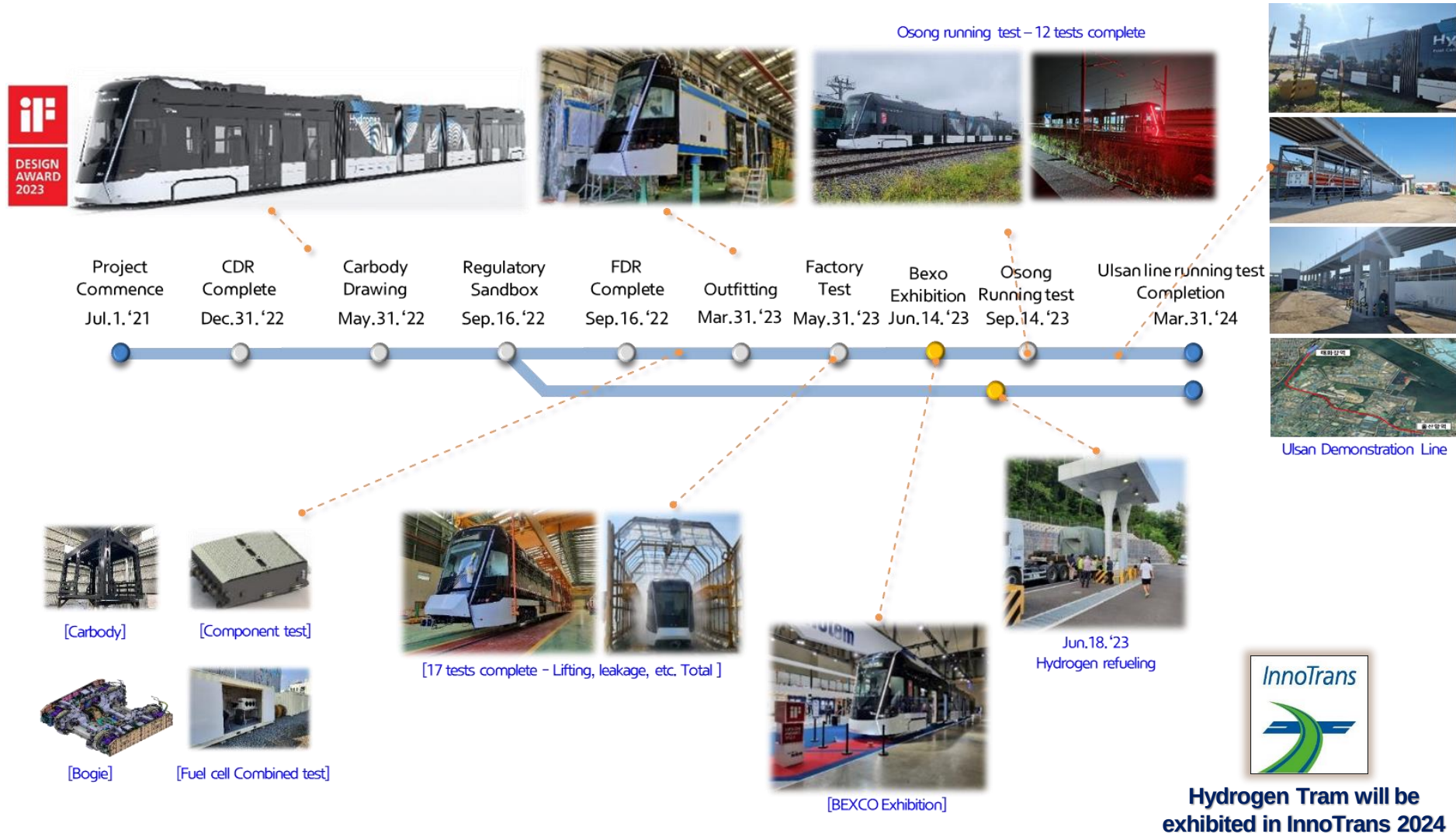
○ Project Schedule



Hydrogen Fuel Cell Tram



Traces of Demonstration



2. Hyundai Rotem Hydrogen Tram

Main Specifications

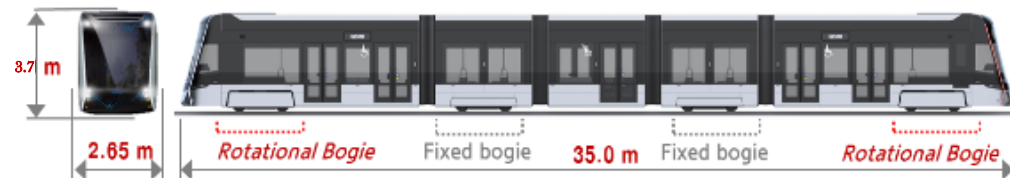


Performance

Maximum Operating Speed / Maximum Design Speed	50km/h / 70km/h
Maximum Running Distance	150 km (1 charging) ※ Variable subject to operating conditions
Train Configuration	5 modules
Acceleration	1.0m/s ²
Deceleration	(Service) 1.2m/s ² , (Emergency) 2.7m/s ²

Major Specification

Gauge	1,435mm
Dimension (L*W*H)	35,000 X 2,650 X 3,700 mm
Floor Height	350mm, 100% Low floor
Carbody Material	Mild Steel
Hydrogen Fuel Cell	4 x 95kW
Hydrogen Storage (per set)	6 x Type IV 175L Tanks (42.24kg)
Bogie	4 (2 rotational bogies & 2 fixed bogies)
Axle Load	11.5 ton
Capacity (total)	305 people (40 seats) (6 p/m ²)
HVAC	HVAC 3 Sets
Door	Double leaf plug-in door (5 per side)



2. Hyundai Rotem Hydrogen Tram

Exterior Design Concept



2. Hyundai Rotem Hydrogen Tram

Interior Design Concept



HYUNDAI
Rotem

iF DESIGN AWARD 2023 (Award date: '23. April. 14)



Hydrogen fuel cell tram

Hyundai Rotem
Yoonoh Nam
Uiwang-si, Republic of Korea

Hyundai Rotem
Uiwang-si, Republic of Korea



Hydrogen fuel cell tram
Hydorgoen fuel cell tram

The Hydrogen Fuel Cell Tram is propelled using electrical energy generated by a hydrogen fuel cell loaded inside the trams, unlike general wire-type trams that require pantographs to receive the electric power through overhead wiring infrastructure. The tram itself can travel a distance of about 150km fully laden on a single charge without producing harmful emissions such as carbon, and actually benefits the environment by purifying the surrounding air as it travels. The design of our vehicle emphasises both a visionary and an environmentally clean impression through the aesthetic appearance and its sustainable functionality.

Hyundai Rotem
Uiwang-si, KR

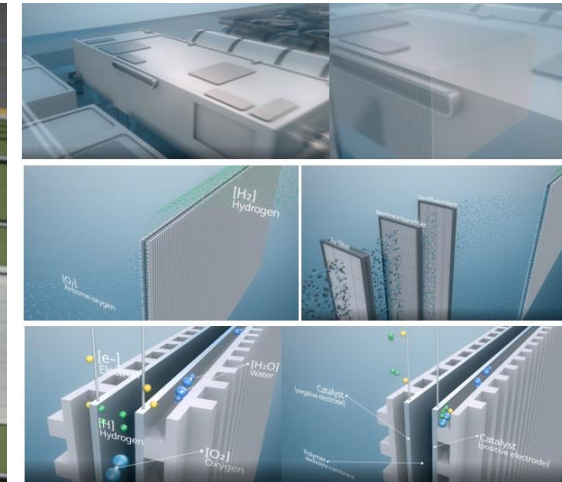
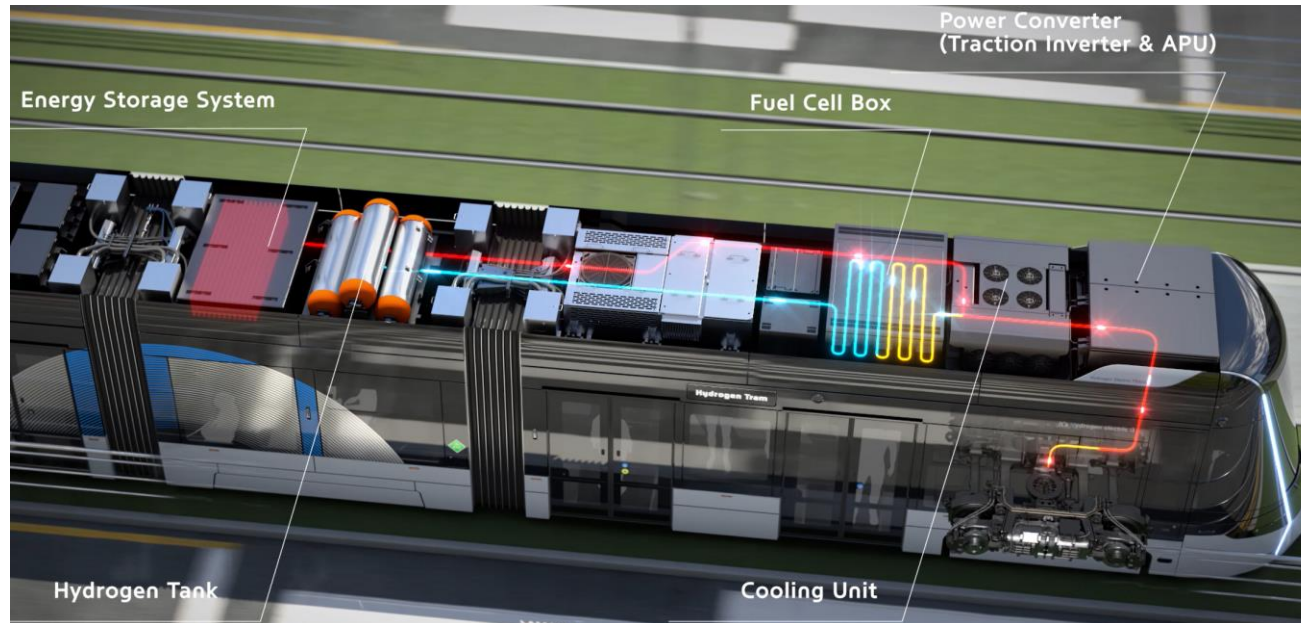
Hyundai Rotem
Uiwang-si, KR

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2. Hyundai Rotem Hydrogen Tram

Mechanism of Hydrogen Tram



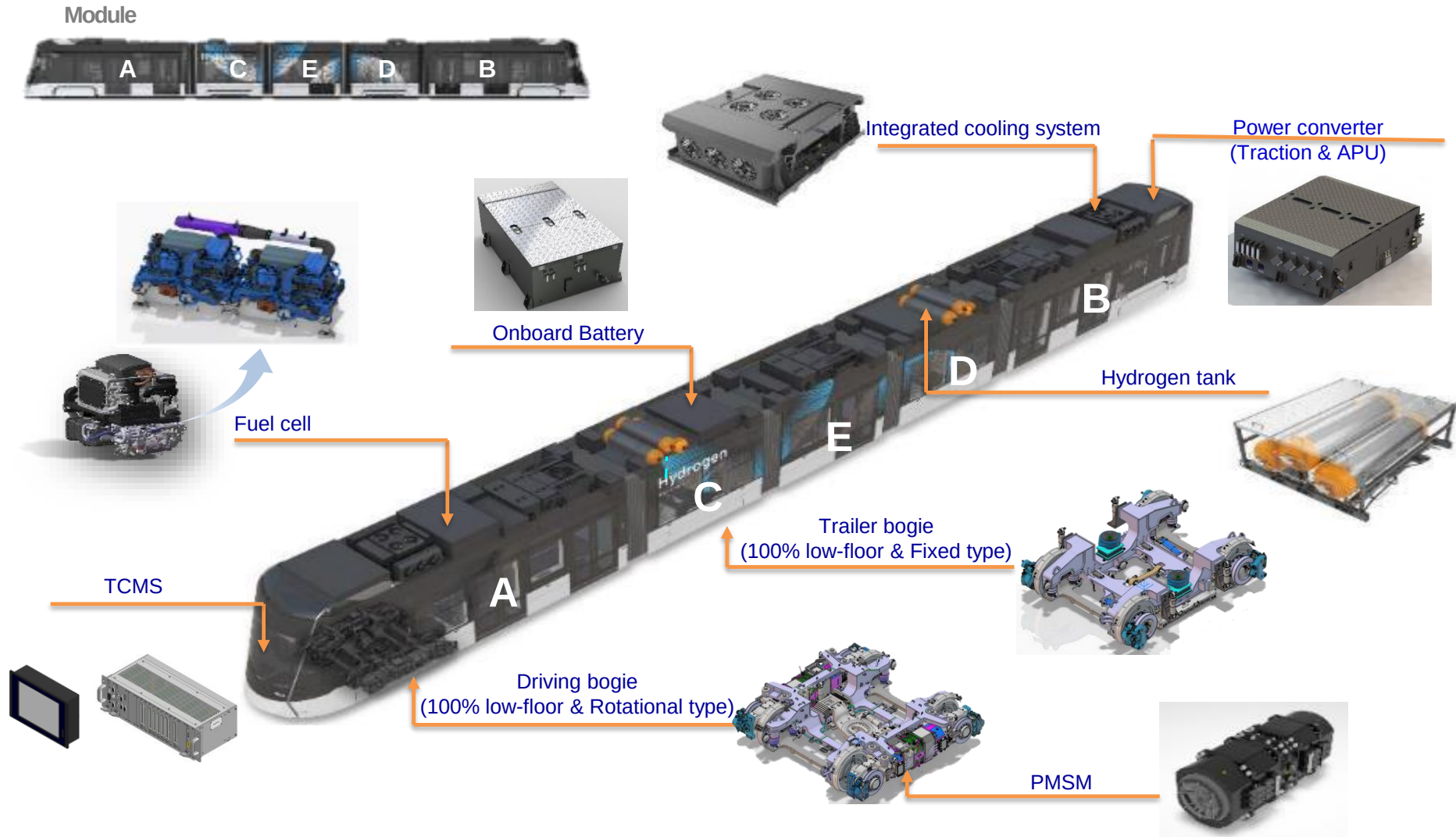
※ Air purification mechanism

- Using 3 step filter for the supply of oxygen in air

Condition Category	Initial Maneuver	Accelerating	Constant Speed	Decelerating
Driving Pattern	Low-load Driving	High-load Driving	Normal-load Driving	Regenerative Braking
Power Source	Fuel Cell (Charging OESS)	Fuel Cell + OESS	Fuel Cell (Charging OESS)	Charging OESS

2. Hyundai Rotem Hydrogen Tram

Details (Tram Configuration)



2. Hyundai Rotem Hydrogen Tram

Details (Specification)



95kW

Fuel Cell Module



95kW

Fuel Cell Module

Fuel Cell Box

Fuel Cell Box



95kW

Fuel Cell Module



95kW

Fuel Cell Module

□ Feature of Hydrogen Fuel-Cell

items	index	specification
Fuel-Cell system	Net output power	85 kW
	Operation Temp.	-30 ~ 45°C
Stack	Voltage range	450 ~ 250 V
	Output power(gross)	95 kW
	Electric current	Max. 335 A
	Heating generation	Max. 99 kW
Type	Cell Type	Polymer Electrolyte Fuel-Cell (PEMFC)

□ Feature of Hydrogen Tank

Storage Gas(mass)	Hydrogen (About 21kg / module)
Hydrogen Tank Standard	R134 UN
Pressure	700 bar
Supply pressure	17 bar
Volume	175L x 3 / Module
Operation Temp.	-40 ~ 85°C
Module size	1,713 x 1,870 x 660 mm

3. Hydrogen Mobility Roadmap

Hydrogen Train Full Line-up

❖ Hyundai Rotem provides a **full line-up of hydrogen train** through phased development

Category	Phase I	Phase II	Phase III
Timeline	2018 ~ 2023	~2024 (design)	2024 ~
Technology	Utilizing HMC Automobile FCs	Utilizing components developed for rolling stock	Utilizing special components developed exclusively for rolling stock
Tasks	Verification of Performance and safety	Improving power density & cooling Increasing hydrogen load capacity	Increasing hydrogen load capacity
Fuel Cell	380 kW (95 kW X 4)	440 kW (110 kW X 2/car)	3 MW(Total power)
Max Speed	70km/h	> 100km/h	160km/h
Running Distance	150km	> 300km	> 300 ~ 1,000km
Rolling Stock Application	Urban Trams	Multiple Units	Locomotives (HST : 2030~)
			

4. Hydrogen Infrastructure

Overall Infrastructure

Storage

Liquid Hydrogen Plant (under development)



Re-fueling system

Tube Trailer Filling Station



On/Off-site Refueling station



Production

Reformer (300Nm³/h)



Mobile Refueling Station



Dispenser



Proven Total Solution Provider



**Proven
Technology**

**Aesthetic
Design**

**Total
Solution**

**Project
Management**

❖ Stability-proven Hydrogen Fuel cell technology by Hyundai Motor

❖ Joint Development with Government



❖ If Design Award 2023
(World top 3 Design Award)



❖ Full package supply
(Tram & Reformer)

❖ System Integration & Integrated system guarantee

❖ Customized & Optimized Solution for Client
(Operation & Maintenance)

❖ Full of experience & management capability

Project	Qty	Velocity	Delivery
Turkey IZMIR	38	50km/h	Completed
Turkey ANTALYA	18	70km/h	Completed
Poland WARSAW	123	70km/h	On-going
Canada Edmonton	40	80km	On-going



Obrigado

Creating Innovation for a Better Future

HYUNDAI ROTEM

EMUS | Ukraine express EMUs



The Ukraine's express electric rail car is operated on the circular line that connects the 4 cities that hosted Euro 2012. This new train features aerodynamic for winter temperatures of -40C.

Project	Ukraine express EMUs
Authority	Ukraine Railways(Hyundai Corp)
Number of vehicles	90cars (9cars X 10train sets)
Contract date	2010.12.16
Delivery date	'12. 5. 31 ~ '12. 10. 07

Specifications

Maximum design speed	176km/h
Formation	9 cars per 1 train set
Dimensions (L x W x H)	21,700 x 3,500 x 4,274(mm)
Gauge	Wide gauge (1,520mm)
Trainset	Mc1+T+MB+M2+T+M1+M2+T+Mc2
Electric Systems / Power Supply	DC 3kV & AC 25kV
The number of seats	579
Passenger capacity	1,162
Carbody	Stainless Steel
Doors	Electric Plug-in doors
Air Conditioner	Roof Mounted A/C, 40,095kcal/h/car
Brake / Coupler	A Microprocessor based electro-pneumatic brake
Bogie	Bolsterless, out-board type
Main electrical equipment	Induction motor / VVVF inverter (Hyundai Rotem's electrical equipment)
Signal	ATC(ALSN)
Applied standard	UIC/EN/IEC/ISO/GOST Standards