

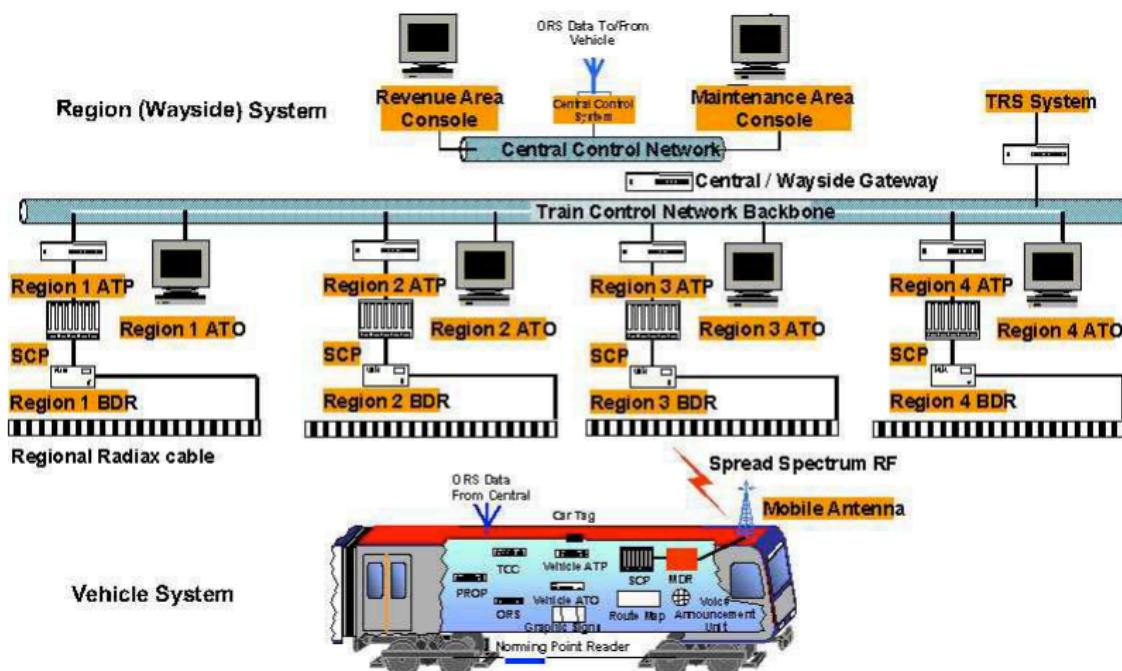
# CBTC Report for vendor Bombardier, Thales and Ansaldi STS

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ISTI CNR Pisa

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# Bombardier System architecture



## Operating mode management

CITYFLO 650 can also be used as an **overlay** train control system or **resignalling**

## Safety and failure management

- Full secondary signalling system using the conventional track circuits, interlockings and wayside signals.  
The solution is based on the Bombardier EBI Lock 950 Computer Based Interlocking (CBI).
- CITYFLO systems allow a **cold start-up**

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## Communication infrastructure and protocol

- The RF communication uses either a **leaky coaxial cable or Line of Sight (LOS)** antenna network along the wayside that transmits data to the trains via their onboard mobile antennas.
- The train has also an internal communication network, which uses the **IEEE-1473 protocol**.

## Interlocking and wayside information integration

- The CITYFLO 650 built-in interlocking function is **located with the regional wayside ATP**.
- The CITYFLO 650 solution can either use the **built-in interlocking function or add optional EBI Lock computer-based interlocking for fall-back system capability** or adherence to local norms.

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## ATS functions

- Manual override requests (when the central operator substitutes the automatic system ATP or ATO)
- Management initiation and termination of service
- Management of train schedules including dwell and headway control
- Management of route assignments for normal operations and failure modes
- Train management (including skip station or station close)
- Remote set or reset of emergency brakes
- Voice communication with the train and supervision
- Control of any power distribution system (SCADA)

## Headway, Train speed and train location determination

### Headway

- CITYFLO 650 is capable of less than **75s headway**
- Metro Madrid Line 1&6: **101s/111s headway**

### Braking models and speed limit protection

No Information

### Train speed and train location determination

- Tracks divided into entity called a “CITYFLO Segment” .  
For example suppose that a train was 25% through segment R1S4 in Moving Block Coordinate System is Region 1, Segment 4, and Offset 25.
- A Norming Point is a **Passive Tag** containing **Location Data**.
- A **Conflict Point** is defined as the end of movement authority.
- Neihu-Muzha Line **maximum speed of 80 km/h**



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## Door management

- Door control requests are issued by the ATO system (both onboard and wayside).
- The ATO system allows precision stopping by the train at stations with a typical **accuracy of +/- 15 cm**

## ATO functions

- Each Region has an independent ATO.
- Ride Comfort Control, e.g. jerk limiting (VATO)
- Stopping accuracy (VATO)
- Speed profile (VATO)
- Door Control Requests (RATO and VATO)
- Onboard and Wayside PIDs and PA (VATO and RATO)

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- Passenger information displays (PIDs)
- CCTV (Closed Circuit TV)
- Public announcement (PA)
- Radio
- Telecoms

End

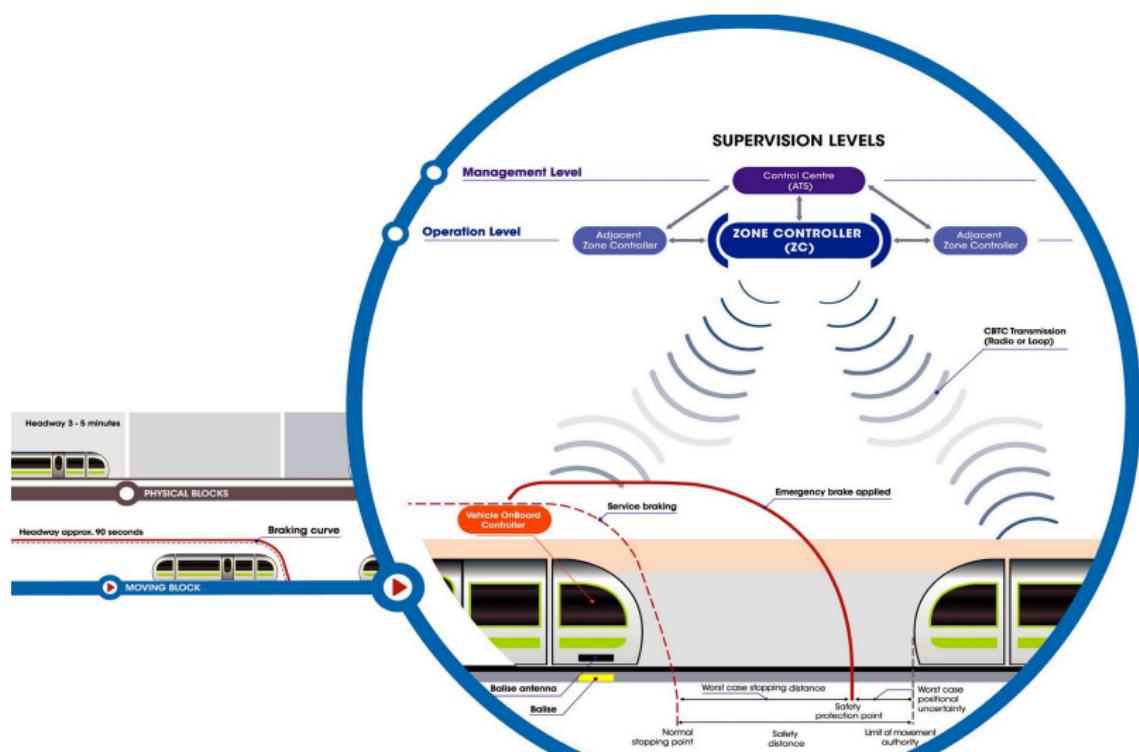
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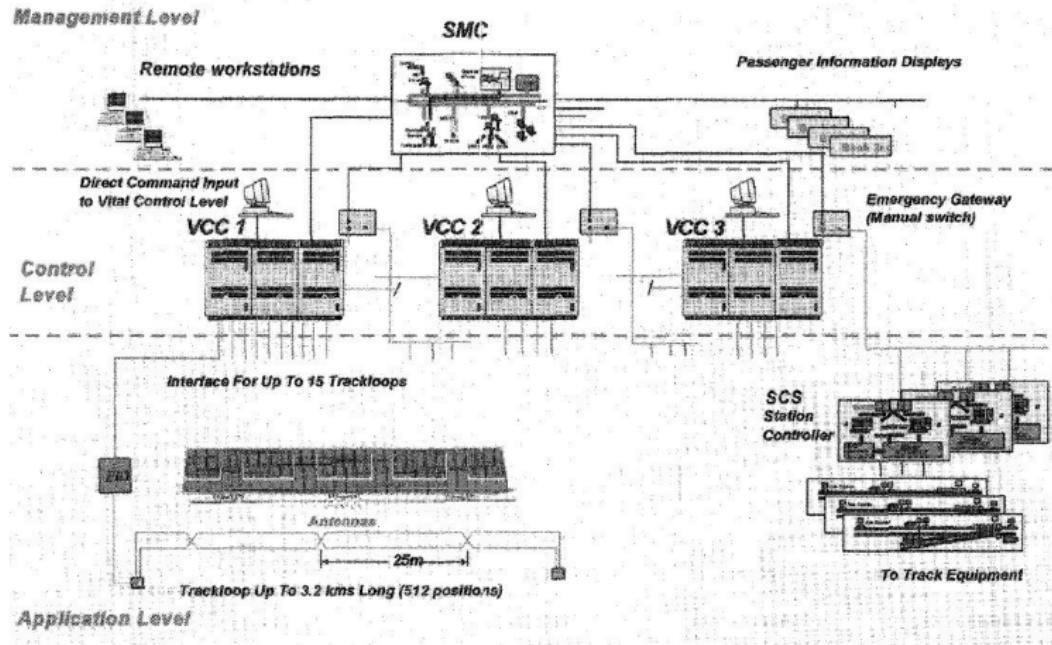
## System architecture

## Thales System architecture



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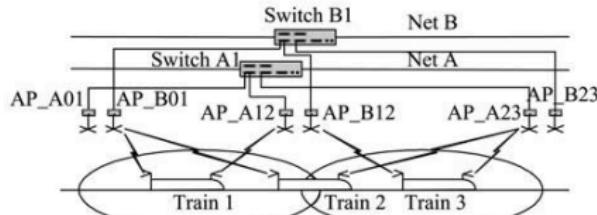
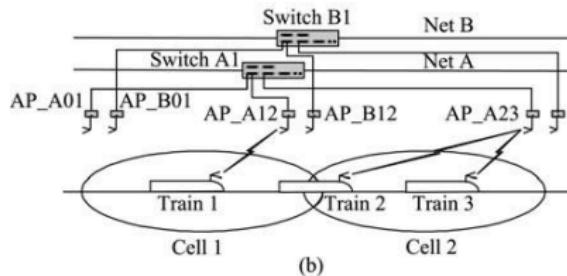
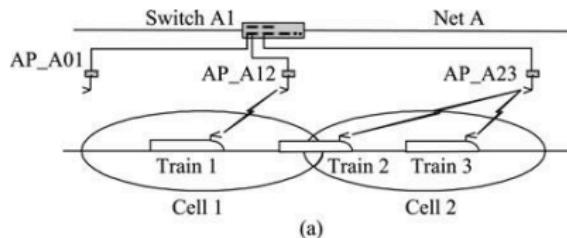
## Thales System architecture Loop Inductive Version



SMC is Supervisory Control Level, VCC is Vehicle Control Computer, SCS is Station Controller Systems

## System architecture

## Thales System architecture Radio Frequency Version



## Operating mode management

**Replacing or overlay** existing signalling

## Safety and failure management

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## Communication infrastructure and protocol

### • Inductive Loop

- *Train-wayside protocol* is Proprietary. VOBC antennas to receive data at 36 kHz and to transmit data at 56 kHz. The protocol used in Alcatel's loop communication has the VCC transmitting an 83-bit telegram to the VOBC at 1200 baud; the VOBC responds with a 43 bit telegram at 600 baud.

### • Radio Frequency

- System are *fully redundant*.
- *Train-wayside protocol* : IEEE 802.11
- *On Board Communication sub-system* has two antennas, one on the front, and one on the rear of the train. Each onboard network device connected to the antenna is a modular component, with two IEEE 802.3 interfaces, as well as one CAN bus interface.

## ATS functions

## Interlocking and wayside information integration

The interlocking functions are provided by LockTrac 6131 ELEKTRA is an electronic interlocking system that provides the highest levels of safety and availability.

### ATS functions

- Train departure, destination assignments and identification assignment.
- Train routing functions.
- Modification of the system operations parameters in response to system delays and Control Room commands.
- Data logging.
- Station platform information display (PID) control
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- In Dubai Metro is configured for a minimum **headway of 90s**.

## Braking models and speed limit protection

The system allows four service brake rates ranging from  $0.4ms^{-2}$  to  $0.8ms^{-2}$ .

The brake rate for a specific train or track section can be adjusted manually from the control center.

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- With IL for speed determination use a **tacho-generators**, used to measure speed, direction and distance in conjunction with an **accelerometer**. SELTRAC train position detection system provides a **6.25m resolution**.
- With radio-based the system use the trackside **transponder tags** assist in train positioning
- Maximum speed** of the trains will be Maximum speed.

## Door management

No Information

## ATO functions

Control train movement with regard to speed, acceleration, deceleration, and jerk.

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- Public announcement (PA)
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- Phone system and emergency
- Advertising information system audio / video
- Supervisory Control and Data Acquisition (SCADA)
- Emergency call points allow direct communication with passengers from centralised Operational control centre.
- Access control: used to detect and warn in the event of unauthorised access to particular areas of the network

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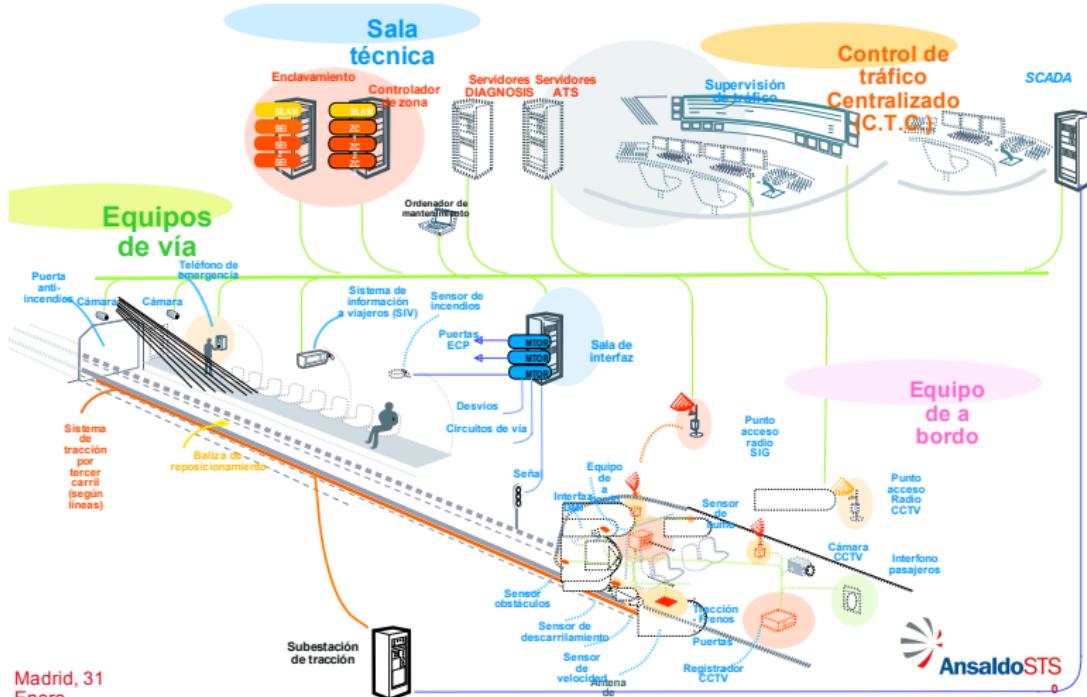
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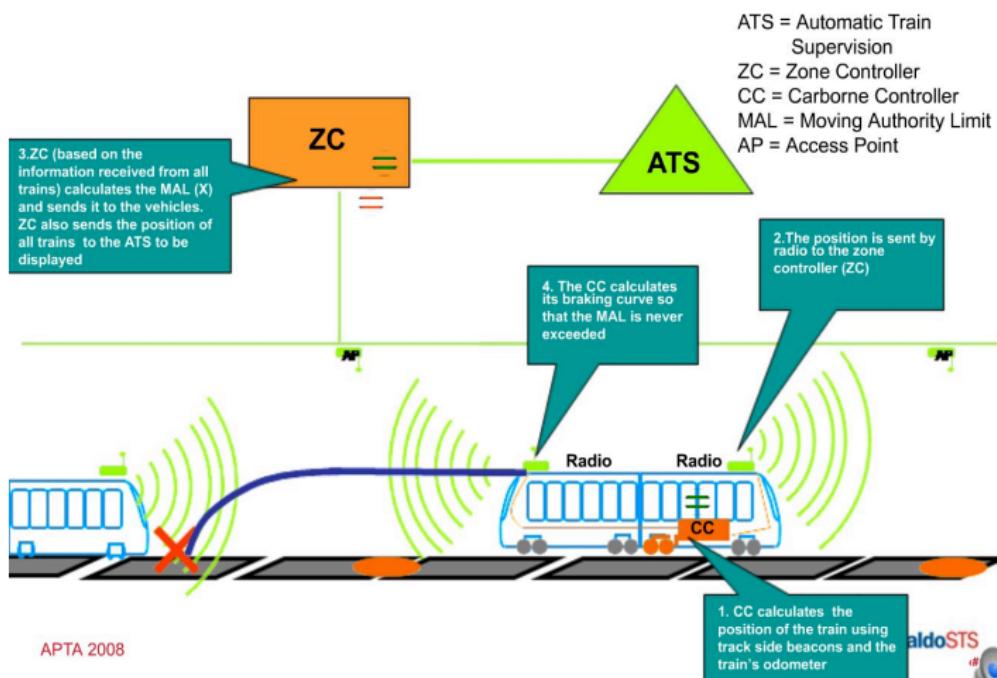
## System architecture

## Ansaldo STS System architecture



Madrid, 31  
Enero

## CBTC System: Train Separation



APTA 2008

## Operating mode management

simultaneous CBTC and non-CBTC equipped vehicles to share the same tracks

## Communication infrastructure and protocol

- **Train-wayside protocol** Radio Frequency: IEEE 802.11
- Fully redundant configurations.

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- Taipei Circular Line **90s** minimum.

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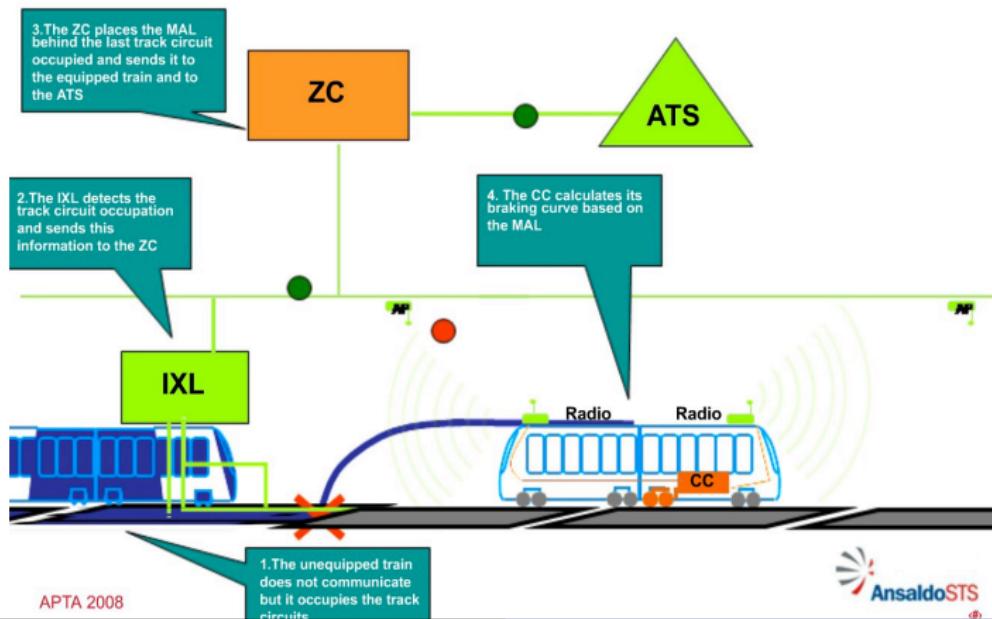
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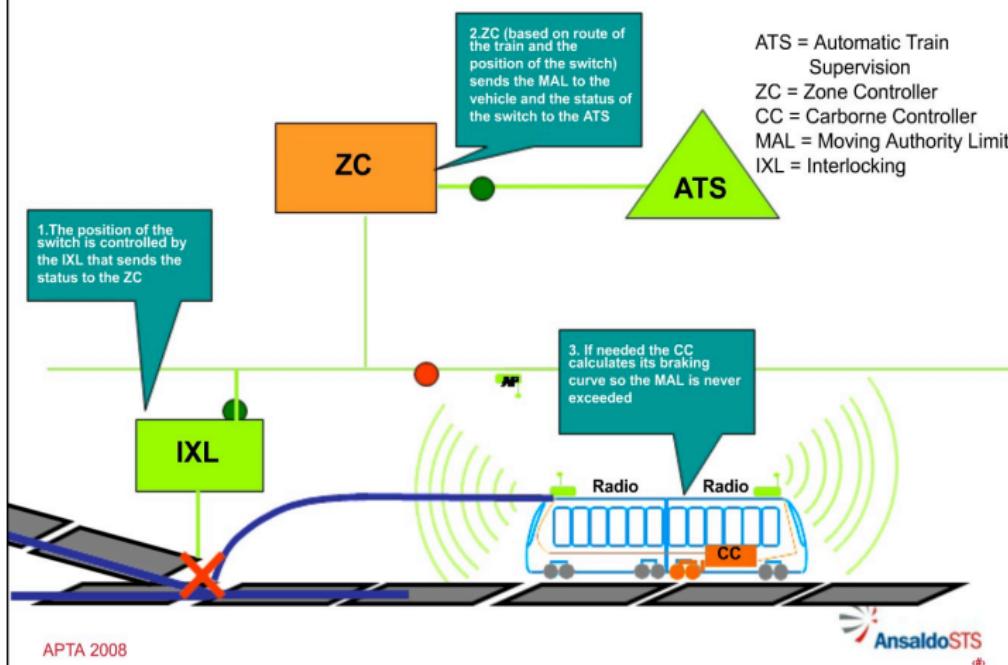
# Safety and failure management

## CBTC System: Unequipped/failed train



# Interlocking and wayside information integration

## CBTC System: Interlocking



## ATS functions

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## Braking models and speed limit protection

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- The maximum train speed is **80km/h** into Copenhagen and Chengdu.

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- Management of programmed stops
- Management of Platform Screen doors
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- Management of overshoot ad undershoot
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- Obstacle detection system
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