Automation of Metro Lines – 60 Years of Innovation at RATP Group

CAFEO 36 — Singapore — November 13, 2018

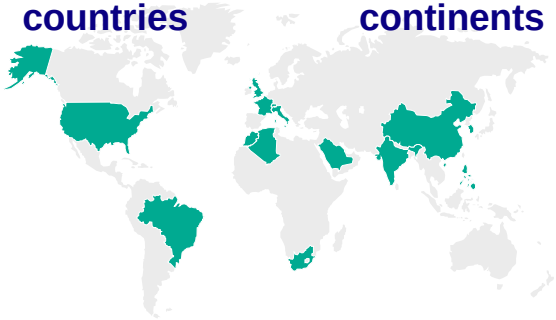
RATP GROUP

RATP Group today

A WORLD WIDE FOOTPRINT

14 countries

4 continents



16 million journeys per day

4,8 billion journeys per year

A GENUINELY MULTIMODAL MOBILITY PROVIDER

- bus
- tram
- cable
- metro
- rail
- sightseeing
- river
- on demand

+

- scooter
- carpooling
- carsharing
- autonomous vehicles

A MULTI EXPERT GROUP

Partnening with smart cities

- Network management
- Design & Development of greenfield infrastructures
- Real estate development

RATP Group – Pionneering the future, our four principles

Leverage technology to transform public transportation

Smart urban transportation solutions, with automation and driverless mobility systems

- Automated metro lines / Autonomous electric vehicles
- Autonomous garage for tramways / buses in our depots

Innovate for a sustainable and smart future

- Transition to zero emission vehicles
- Bus 2025 : electric buses

Innovate in the way we collaborate with our ecosystem

- In-house innovation and partnerships with other firms, including the start-up eco-system
- Our dedicated fund for start-ups : RATP Capital Innovation

Build together the cities and the communities of tomorrow

- « Mobility for all » : reduce distances, open doors to opportunities, bring people together
- Skills transfer and employment opportunities
- Inclusion

RATP Group, a world leader in automated mobility

GROUPE RATP

Driverless Metro

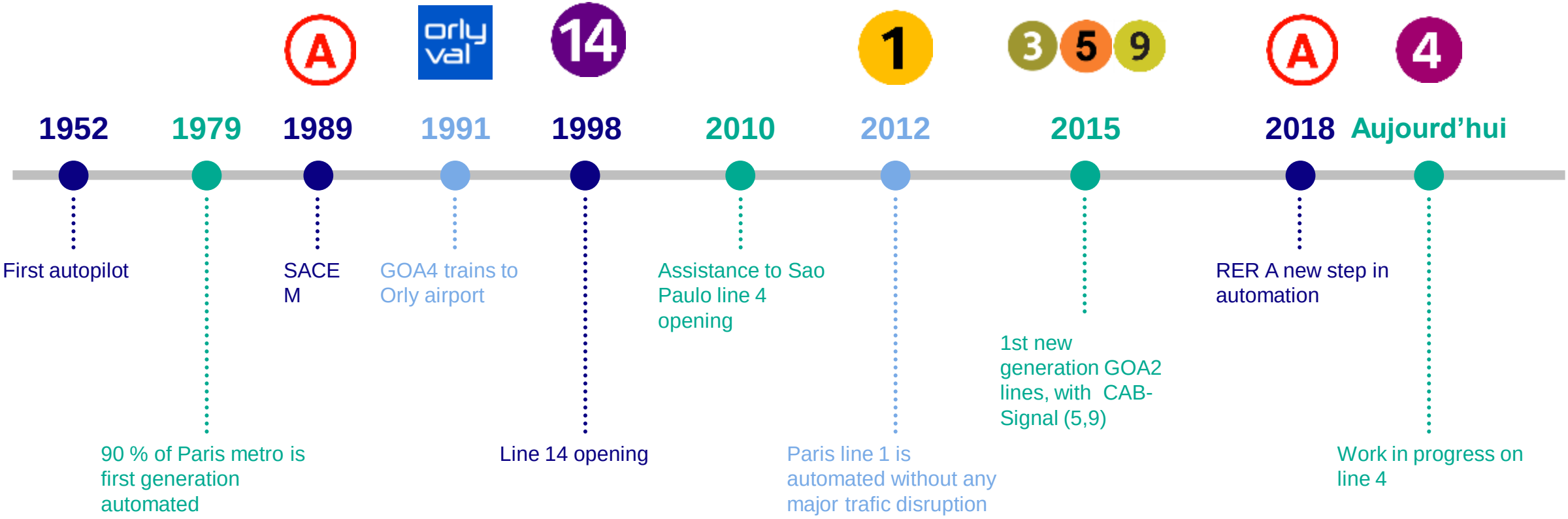
Autonomous buses

Intelligent garage

Autonomous shuttles

SACEM & CBTC

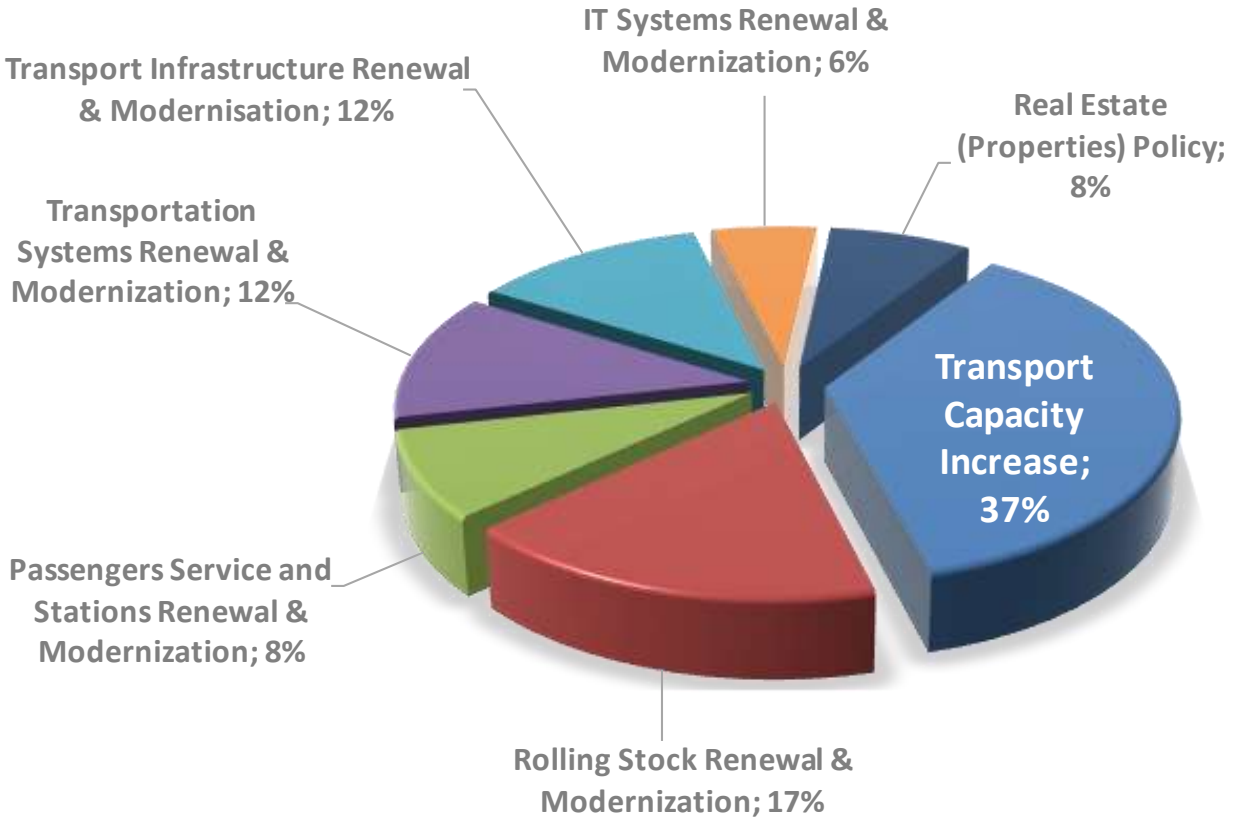
60 years of innovation in automation



Significant investment to maintain, renew, modernize…

€1,6 billion
investment per year
2012-2020

RATP's Investment Distribution



RATP's achievements

1

Brownfield
GoA2→GoA4
CBTC Siemens

750 000 passengers / day
30 000 pphpd

System: 2011
Trains : 2010

World 1st automation of an existing line without traffic disruptions

3 5 9

Brownfield
GoA2→GoA2
CBTC Siemens, Ansaldo and Alstom

350 000 p/d	365 000 p/d	700 000 p/d
21 000 pphpd	19 000 pphpd	19 000 pphpd
S 2009 **T 1967**	S 2013 T 2010	S 2015 T 2013

GoA2- Modernization
3 interchangeable CBTC suppliers : Ansaldo, Alstom, Siemens
1st new generation GoA2 with CAB-Signal (lines 5,9)

4

Brownfield
GoA2→GoA4
CBTC Siemens

740 000 p/d
30 000 pphpd

System 2020
Trains **1997, 2010, 2019**

Automation and Extension without traffic disruptions

13

Brownfield
GoA2→GoA2
CBTC Thalès

600 000 p/d
22 000 pphpd

System 2008
Trains 1977

Succeeded in overcoming the initial difficulties of the project, Modernization : 2006 → 2016

14

Greenfield &
Brownfield
GoA4→GoA4
CBTC Siemens → ?

550 000 p/d
30 000 → 40 000 pphpd

Syst1998, 2024
Trains1997, 2010

World first GoA4 large capacity metro Extensions and GoA4 migration

A

Brownfield
GoA1→GoA2
Alstom

1 300 000 p/d
75 000 pphpd

ATP Sacem:1989
ATO : 2017
Trains :
1997→2005,2011

GoA2 – Modernization with ATO on SACEM

RATP Group : a worldwide expertise

ORLY VAL	SAO PAULO	ALGIERS	MUMBAI	SEOUL
				
Greenfield **APM - GoA4** VAL Siemens 15 000 pas./day 2 000 pphpd System : 1991 Trains : 1988	**Greenfield** **GoA4** CBTC Siemens 600 000 pas./day 31 000 pphpd System : 2010 Trains : 2010	**Greenfield** **GoA2** CBTC Siemens 100 000 pas./day 21 000 pphpd System : 2011 Trains : 2008	**Greenfield** **GoA2** CBTC Siemens 260 000 pas./day 18 000 pphpd System : 2014 Trains : 2014	**Greenfield** **GoA2** ATC Alstom 400 000 pas./day System : 2009 Trains : 2009
Orly Val is synchronised with RER B, to serve Orly Airport	**1st GoA4 line in South America**	**1st metro line in Maghreb and 1st CBTC in Africa**	**First metro line in Mumbai**	**Renewal of the L9-operation contract for ten years**

Advantages of Automated metro

Functional performance

CAPACITY

- Reduces headway
  *Line 1 and 14 can reach a headway of **85 seconds***
- No more driver cabin (GoA4) : better train capacity

ADAPTABILITY

- Possibility to add more trains instantaneously
- Reduced marginal cost of operation (enables to increase the service off peak for instance)

+ 30% capacity

For Paris line 1 when converted to GoA4.

Headway of 100s all day long on line 1 during heavy maintenance work on line A during summer

RELIABILITY

- Coasting and dwelling times are precisely controlled

RESILIENCE

- After an incident, back to normal within minutes

100% peak-periode passages (+8% / L1 before automation)

Feedback on line 1: synthesis

Line 1 automation

- East – West backbone of Paris
- Oldest line in Paris
- Major touristic areas and railway stations
- 1st heaviest traffic in Paris metro

To meet the challenge, RATP has developed several innovations

MIGRATION | **NO TRAFFIC INTERRUPTION** | **MIXED FLEET OPERATION**

- Installation of mid-height platform screen doors
  - on 100+ year old platforms
  - in tight curves (R = 50m)
  - outdoors
  - on a steel bridge
  - with every single door installed functional each morning
- System Test and Commissioning at nights and shadow mode during the day
- Progressive launching of automated trains, one by one, over 13 months

>98% satisfied passengers

Less than 1% of passengers disturbed

13500 night work sites
between 2007 and 2011

Demonstration of the usefulness of the integrated business model (engineering, operation and

Automation GoA2 to GoA4 without traffic interruption

Line 1 – “world premiere” - Line 4 ongoing

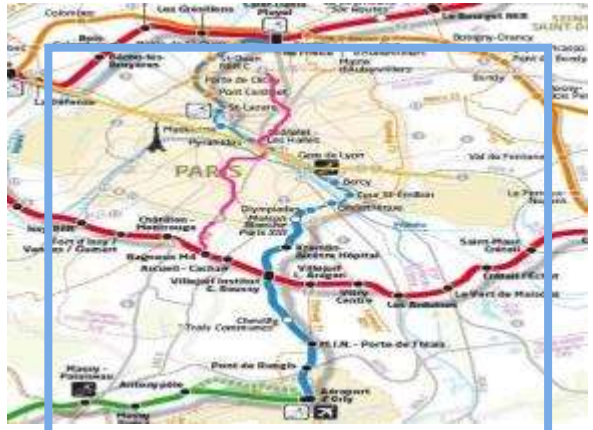
Line 1	Line 4
• 1900	• 1908-1910
• 17 km, 25 stations	• 14 km, 29 stations
• **East / West** backbone	• **North / South** backbone
• Complemetary capacity for **RER A**	• Complementary capacity for **RER B**
• Ridership : **> 725 000 pax / day**	• Ridership : **> 700 000 pax /day**

Line 4 automation : project opportunities

Improvement of service quality offered by an automatic system

Short-term renewal / modernization of line 4 **infrastructure**

Redeployment of automatic trains **from line 14**



An opportunity that makes sense in the context of **the "Grand Paris Express" project**

Line 4 automation : 5 sub-projects

Challenges to overcome

- A 100-year old line
- **No** traffic **interruption**
- 3 **different generations** of **automated rolling stock**
- **Recent operating control centre** helping drivers' management
- **Sensitive infrastructure**
- **Reduced headway of 105 seconds** during peak hours

5 sub-projects

- **Infrastructure upgrades**
- **Platforms and PSD**
- **Change management**
- The **automated system**
- **Rolling stock**

Infrastructure upgrades

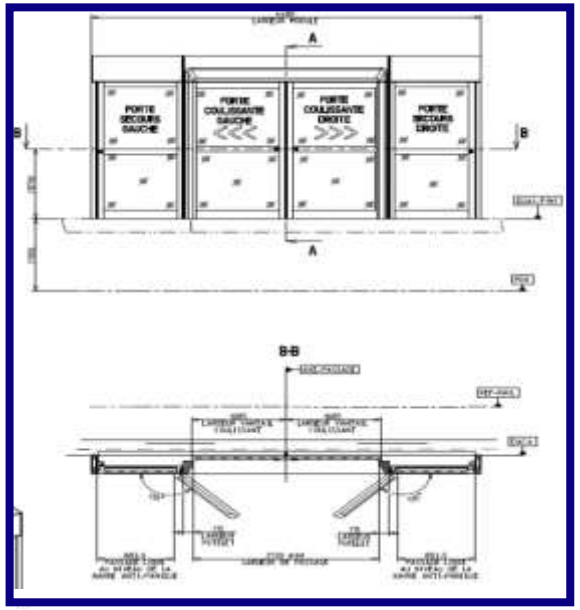
- Renewal of obsolete equipment
- **Infrastructure adaptations** (signalling, traction power supply, track, low voltage equipments…)

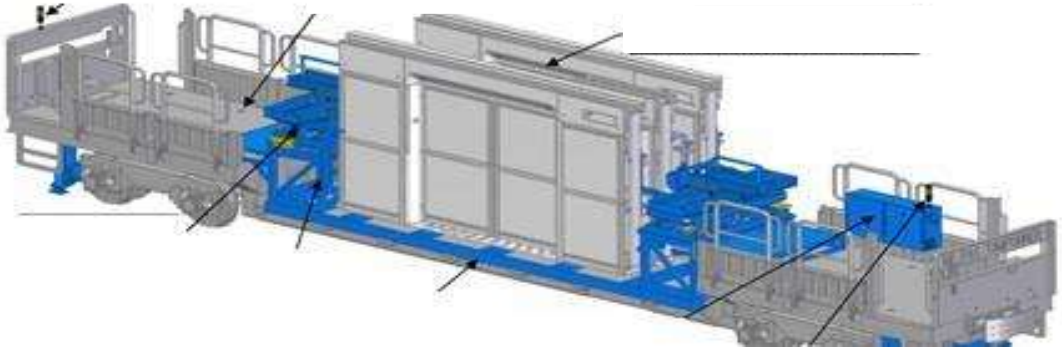
Platforms and platform screen doors

REFURBISHMENT OF PLATFORMS

PLATFORM SCREEN DOORS

- 2.50 m high PSD
- Modular PSD
- Anchored in the platform
- Retrofit on >100 years old platforms (sometimes in curves)
- Specific train dedicated to works every night
- Every installed module functional the same day





The automated system:

Unattended trains will be operated by a cbtc system including a new operation control centre (occ)

MIGRATION TO A NEW OCC

Dealing with the current OCC to keep drivers'management features

Systems functionally identical to those deployed on line 1 & upgraded with feedback

IMPLEMENTATION OF AUDIO VISUAL MEANS

Continuous high definition videos

Change management

A SOCIAL PROJECT

- Retraining some of the drivers to new high skilled jobs
- Benefits of operating an entire network
- The new line management organization should be inspired by lines 14 and 1, which proved to be a success.

Potential barriers or challenges to metro automation

Metro automation is a …

proven

scalable

adaptable

… solution that meets the needs of diverse mobility scenarios

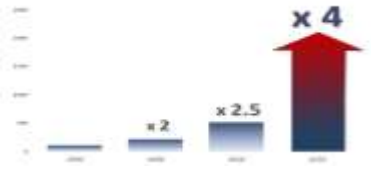
But

In case of modernisation (brownfield projects)

- **Complex project in design and execution :** strong engineering and management competences required
- Safety during transition stages when modifying an existing system

RATP's experience

CAPITALIZATION



Exponential growth of automatic metro, UITP

- **Greenfield**
- **Brownfield**
  GoA2, GoA4 modernization
  Automation **without traffic disruptions**
- **Extension** during **automation**
- Different generations of automated **rolling stock**
- Success with **many industrials** (including interchangeability)

SYSTEM INTEGRATION

- **System design**
- **System safety case** / sub-systems safety assessment
- **Interface** management
- Installation works **coordination**
- System **test & commissioning**

Projects **on time, within scheduled costs - expected results**

Operation, maintenance & **engineering** know-how, guaranteeing **safety and security**

Systems **built to last** : long-term solutions for more than **30 - 40 years**

Metro automation projects

Key success factors

RATP takes a **system approach**, by **integrating** these sub-projects together.

We do :

- **System design**
- **System safety case** / sub-systems safety assessment
- **Interface** management
- Installation works **coordination**
- System **testing & commissioning**

STANDARDISATION / CAPITALISATION

INTEGRATION

INNOVATION IMPLEMENTATION

Autonomous shuttles : > 80 000 passengers on board RATP Group shuttles

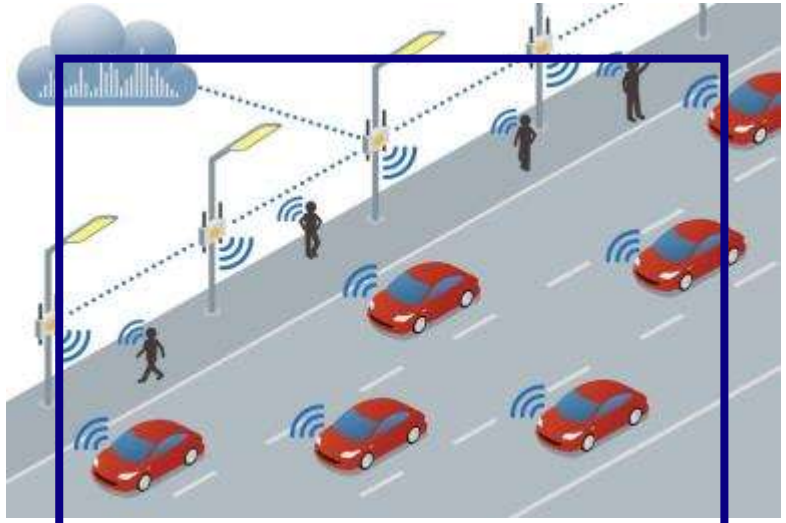
2016
- Seine River

2017
- Paris (pont Charles de Gaulle)
- Austin, TX
- Boulogne Sur Mer

2018
- Paris Vincennes **(on going)**
- CEA Saclay
- STIB Bruxelles **(on going)**

2019
- New services to be developed in 2019

Ground breaking projects for 2019 to develop new mobility solutions



Connected Autonomous vehicles (5G, VtoX) in Paris

New services to enhance customer experience

BRT line 393 Automation pilot of a major bus line

Automation to enhance operational efficiency

Intelligent garage (bus)

Intelligent garage (tram)

Equipment assisted driving

RATP GROUP