UIC DIGITAL CONFERENCE

10 December 2019

UIC HQ, PARIS

PROGRAMME

- Opening of the conference by François Davenne — UIC Director General
- Opening speech by Gianluigi Castelli — Chairman UIC and Chairman FS
- Presentation by Loïc Hamelin and Giuliana Barbarino — SNCF: "Open software: enhancing operations"
- Presentation by Bill Nie — CEO FATRI: "What about Quantum Sensing in the new Smart City Transportation paradigm?"
- Presentation by Joachim Bürkle — ZERO.ONE.DATA: "A success story for innovative way of working: cooperation of Rail industry, Corporate Startups and Startups "
- UIC Digital Platform by Francis Bédel — UIC Chief Digital Officer: "Overview 2019 activities and roadmap 2020

*UIC digital Awards 2019 (*Presentations of their projects by the selected startups)

- Bulldozair — Services Category
- Cylus — Safety Category
- National Engineering Laboratory — Productivity Category
- Supraways — Special Prize

- Digital Awards ceremony
- Conclusion by François Davenne

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OPEN SOFTWARE : ENHANCING OPERATIONS

UIC digital conference– December, 10th 2019 - Giuliana BARBARINO & Loïc HAMELIN

Open Source Railway Designer

Team SNCF Réseau DGEX Solutions

Bertrand Houzel

Naïma Aftab
Giuliana Barbarino
Lucien Devars Dumayne
Benjamin Gaultier
Paul Guénézan
Loïc Hamelin
Guillaume Lecœur

PROJECT CONTEXT

Political context

- ✓ European railway reform
- ✓ Opening up the market to competition
- ✓ State demand for greater economic performance

Technical context

- ✓ Non comparable results
- ✓ More and more softwares and « black box » solutions
- ✓ High licencing costs for research laboratories and operation offices

PROJECT GOALS

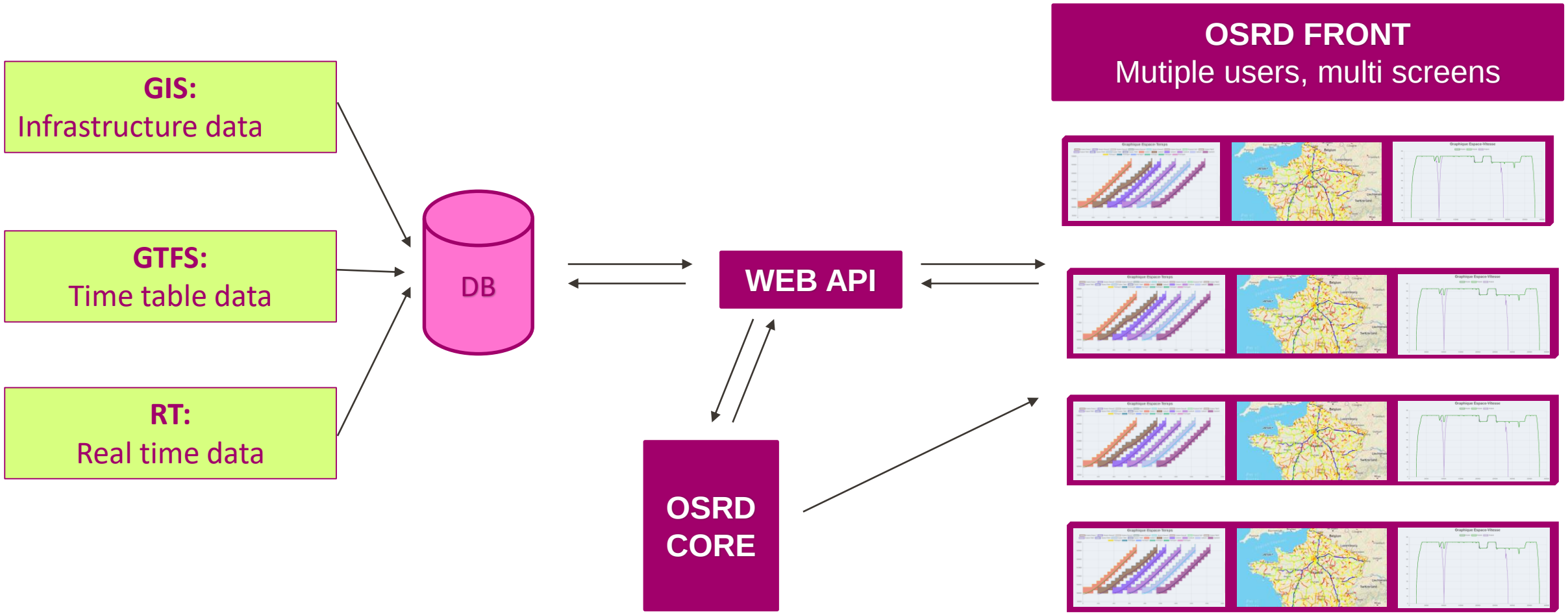
Provide an *Open Source* solution for the software and the data

- ✓ Standardize algorithms
- ✓ Provide auditable results
- ✓ Integrate academics contribution into the process to improve the overall performance
- ✓ Build a community around the project through open access

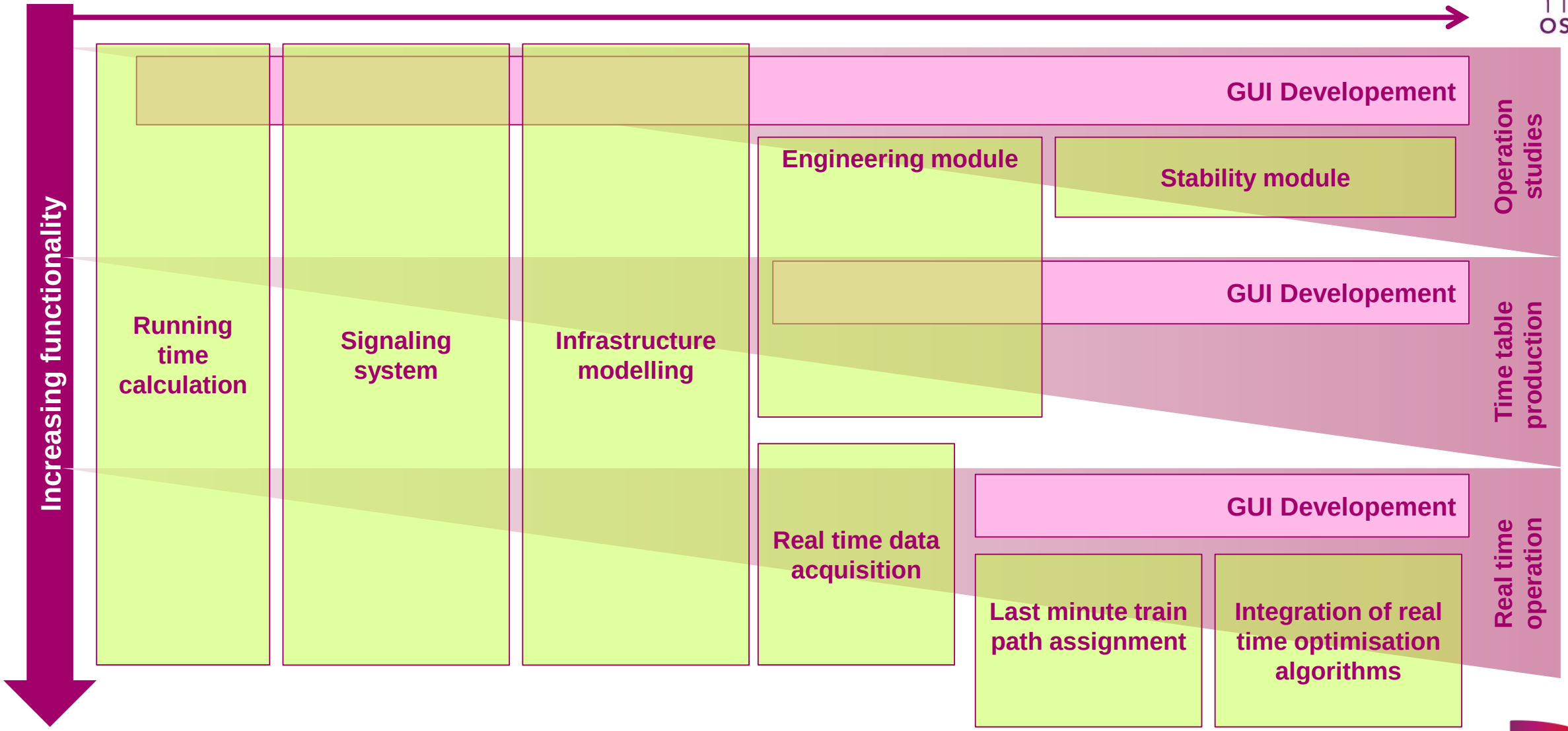
Create a modular solution that will improve over time and allow

- ✓ High computational load
- ✓ Connection to other softwares
- ✓ Peripheral development of various modules
- ✓ Implementation of additional algorithm (optimization…)

GENERAL ARCHITECTURE



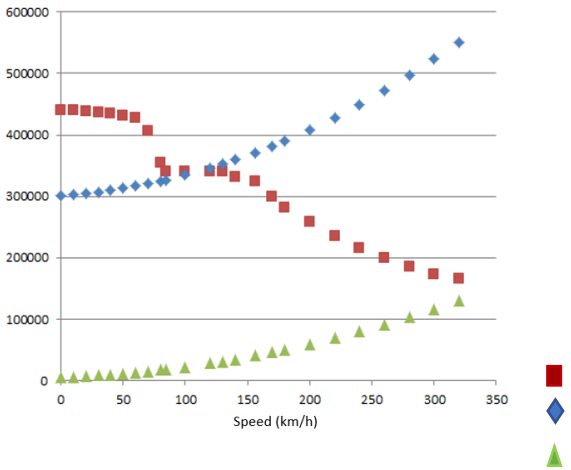
FUNCTIONNAL ROADMAP



STATIC APPROACH : RUNNING TIME CALCULATION

ROLLINGSTOCK:

- Physical train characteristics: length (l), mass (m)
- Inertia of rotating mass (i)
- Traction force (T) curve for each power supply
- Resistance formula (Ra)



$Ra[N] = A + B\,v + C\,v^2$

- A = 0,6368 daN/tonne
- B = 0,00755 daN/tonne
- C = 0,0001199 daN/tonne

Traction force [N]
Ra [N]
Ra + slope of + 35 mm/m [N]

INFRASTRUCTURE:

- Line profile: gradients (d), radius (d=800/R), maximum speeds (v)

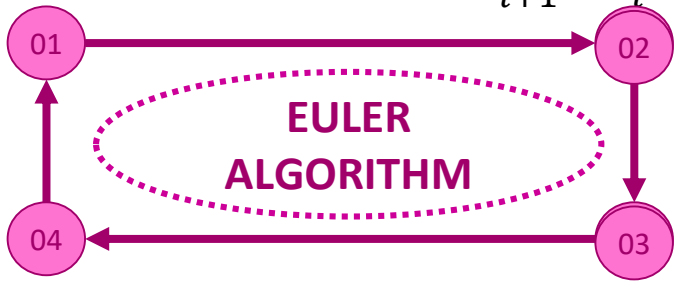
Equation model for the train movement:

Time discretization

$$t_{i+1} = t_i + \Delta t$$

Positon of the train x

$$x_{i+1} = x_i + v_i \cdot \Delta t + \frac{1}{2} a_i \cdot \Delta t^2$$



Train speed

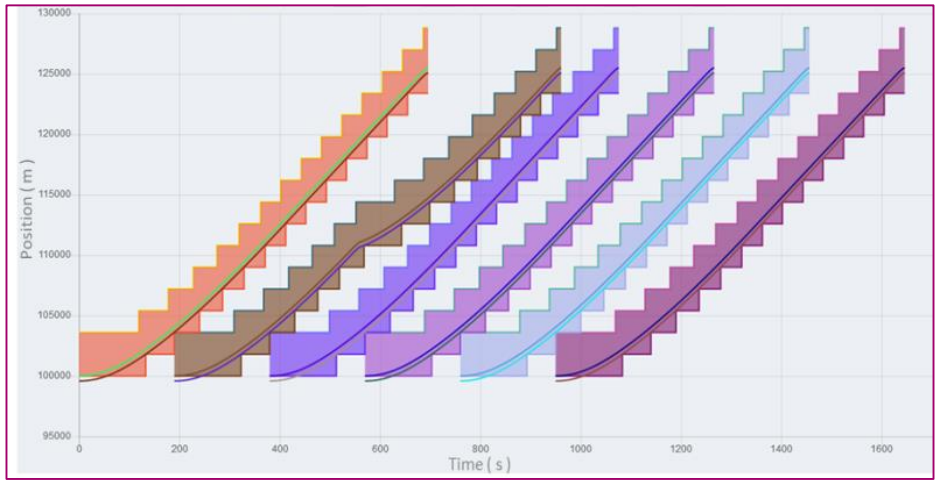
$$v_{i+1} = v_i + a_i \cdot \Delta t$$

Forces and accelerations

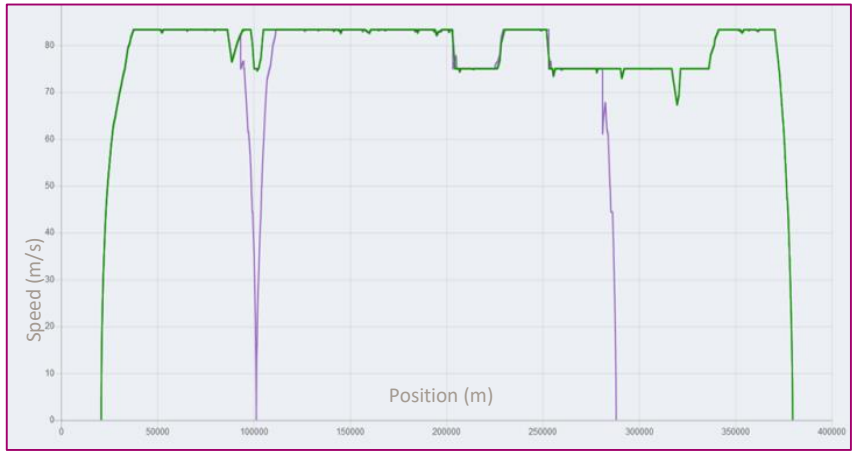
$$a_i = \frac{T(v_i) - Ra(v_i) + m \cdot g \cdot d(x_i)}{m \cdot i}$$

STATIC APPROACH : RUNNING TIME CALCULATION

- ✓ Plotting the train position during the time : the running time calculation for each train is performed indipendently, the conflicts could be graphically displayed
- ✓ Plotting the train speed at each positions

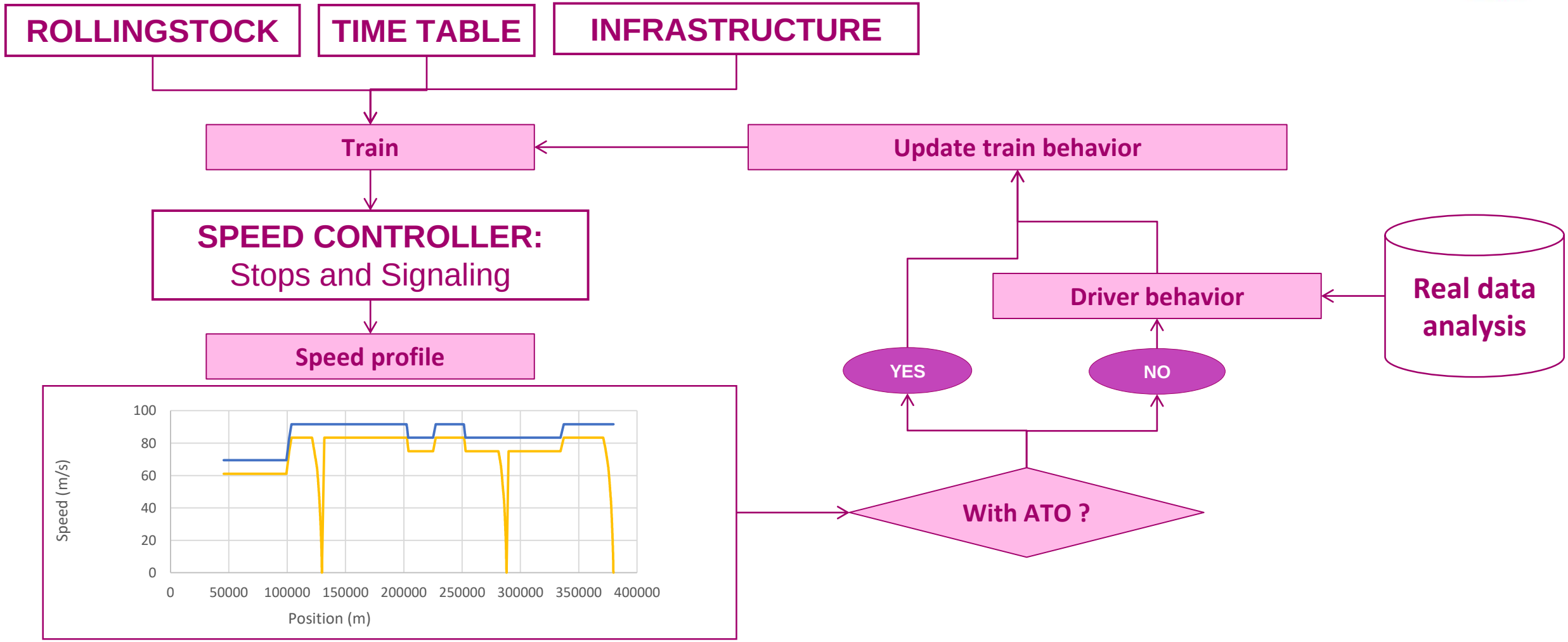


Time-space graph



Space-speed graph

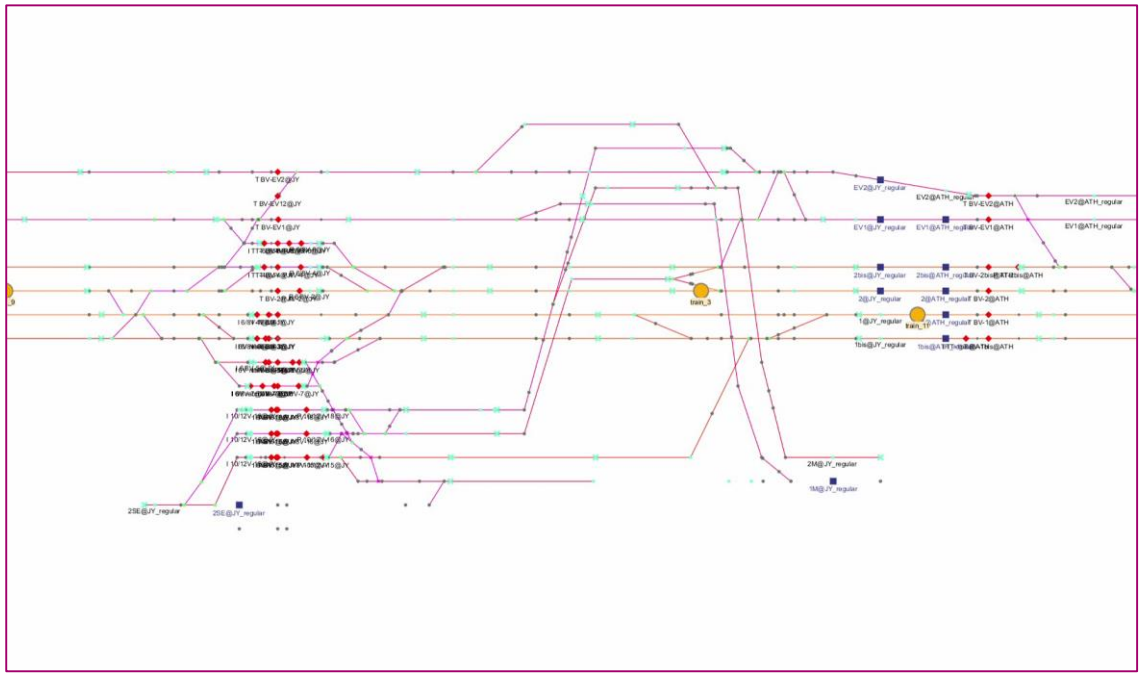
DYNAMIC APPROACH : SIMULATION



INPUT GIS RAILWAY INFRASTRUTURE

INFRASTRUCTURE OBJECTS:

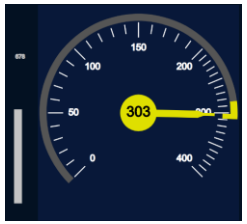
- Nodes
- Edge
- Station, routes
- Tracks
- Signals, block sections
- Switches, crossings



DETAILLED SIGNALING FOR DRIVING SIMULATION

01

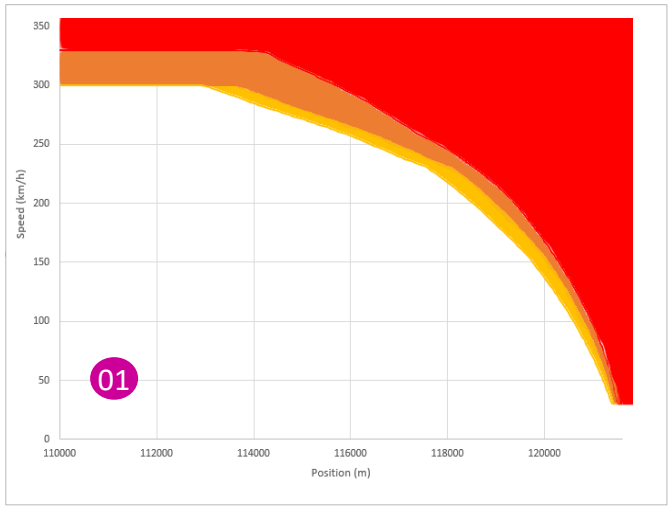
02

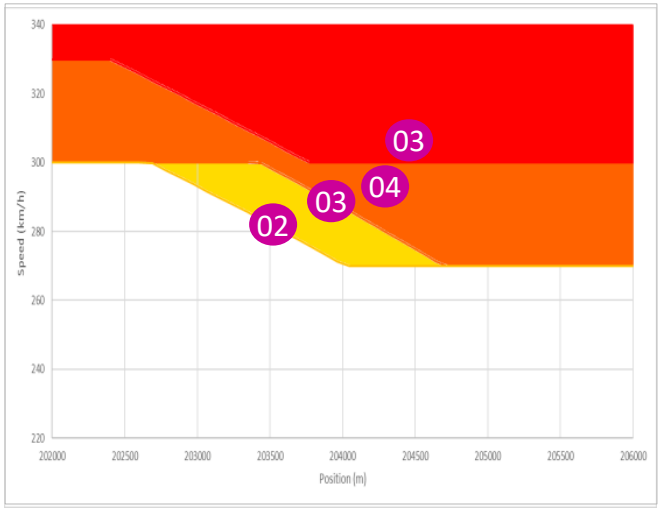


03

04

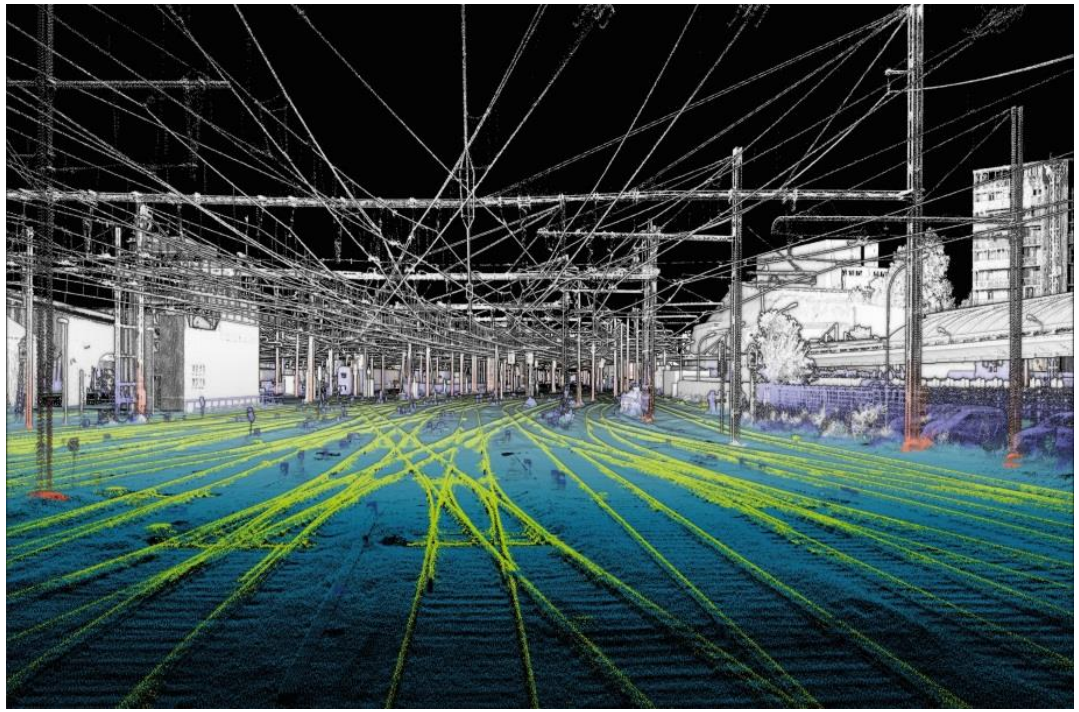
05





IMPLEMENTED SIGNALISATION:

- Block automatique lumineux (BAL)
- Transmission voie machine 300 (TVM300)
- Transmission voie machine 430 (TVM430)
- **ERTMS**



ALTAMETRIS

Merci

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Quantum technology used on Smart Bearing of high speed railway

FATRI United Testing & Control (Quanzhou) Technologies Co., Ltd.

High speed rail axle bearing needs to be replace every 1 year.

The potential failure is not easy to find, Since the traditional sensor installation position is far away from the bearing failure point, the sensor signal is weak

TMR Magnetoresistive Sensor for Bearing Cage Speed Monitoring

On 13 August 2000, a Qantas Short SD360-300 with two pt6a-67r engines was stopped 35 minutes after take-off by a failure of bearing no. 1 on the right engine；

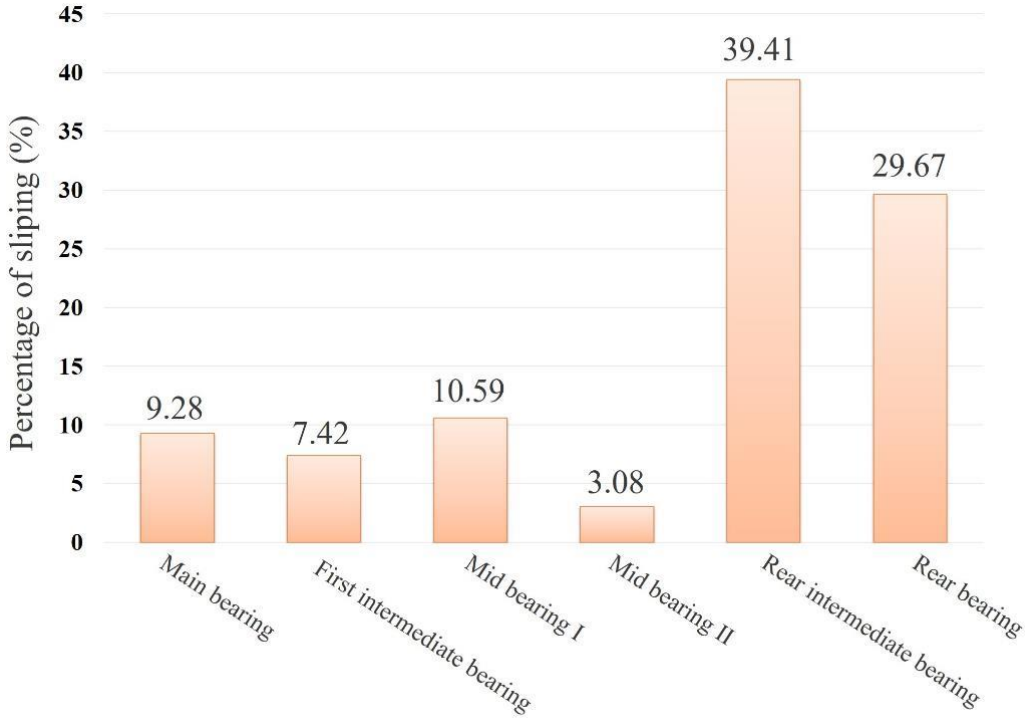
——— Chen Guang. Aero-engine, 2005, 312(2): 4-5.

According to the statistics, among the 18 crashes of the American a-7 aircraft caused by engine failure, 5 of them were caused by the damage caused by spindle bearing failure, and the flight accidents caused by bearing failure accounted for about 27% of the total failure of the mechanical system of the aero-engine；

——— Tao Chunhu. Beijing: National Defence Industry Press , 2000.

At the end of 1990s, the maintenance records of more than 3000 main shaft bearings of aeroengines and the statistical analysis results of nearly 100 main shaft bearing failures of aeroengines showed that slippage injuries accounted for as much as 39.41% of main shaft bearing failures of aeroengines

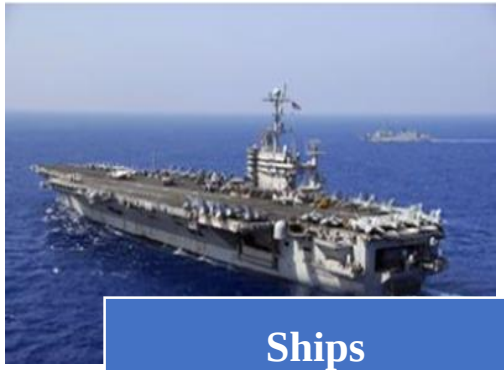
——— Jiao Yujie, Zhou Zhilan. Bearing, 1998, 6: 6-7.



Failure Data Statistics of Aircraft Engine Spindle Bearing Sliding and Rubbing

Industry Applications

Aerospace



Ships

Rail Traffic

Wind Power

Nuclear Power

Rotating Machinery

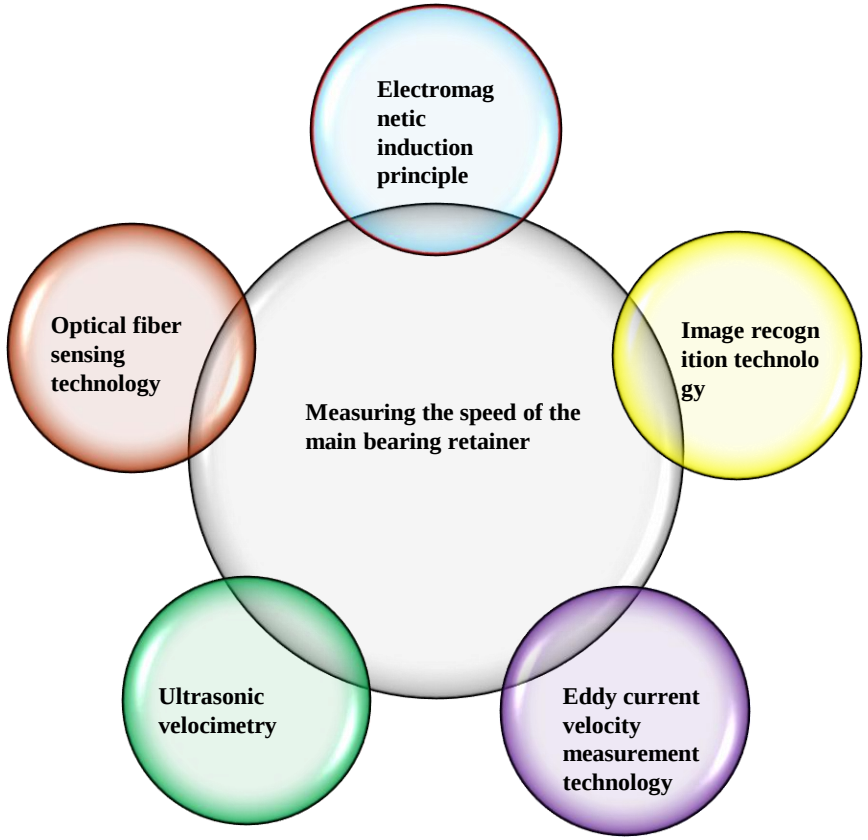
In 2020, global bearing production will reach 150 billion sets.

Systematic Solution

Systematic Intelligent Bearing Monitoring Scheme

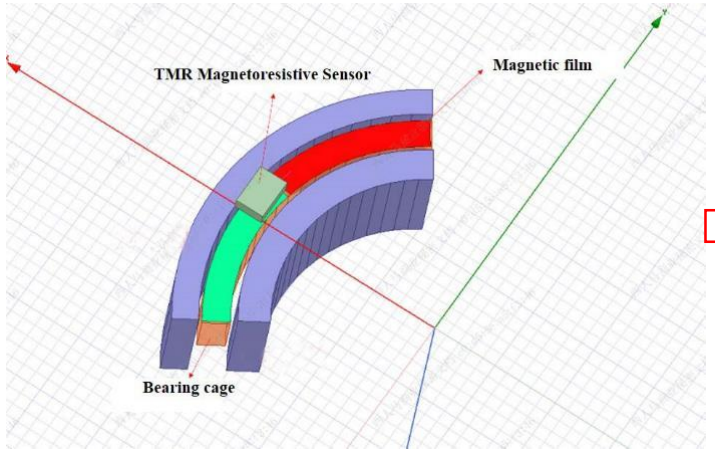
Smart bearing systematic solutions include: the micro accelerometer based on embedded in the bearing outer ring and after special processing of cage to realize the integration of bearing vibration and rotation speed monitoring, the bearing inner ring and outer ring, rolling body and the breaking of the cage, cage skid, wear, pitting, scratches and other real-time monitoring, fault bearing the full cycle of monitoring. Because of the wear of the bearing rolling element, the rolling element is not simply rolling but sliding, so the bearing cage will produce relative motion inconsistent with the theoretical rotation, so we need to detect the relevant rotation.

TMR Magnetoresistive Sensor for Bearing Cage Speed Monitoring



Measuring method for speed of aircraft Engine main shaft bearing retainer

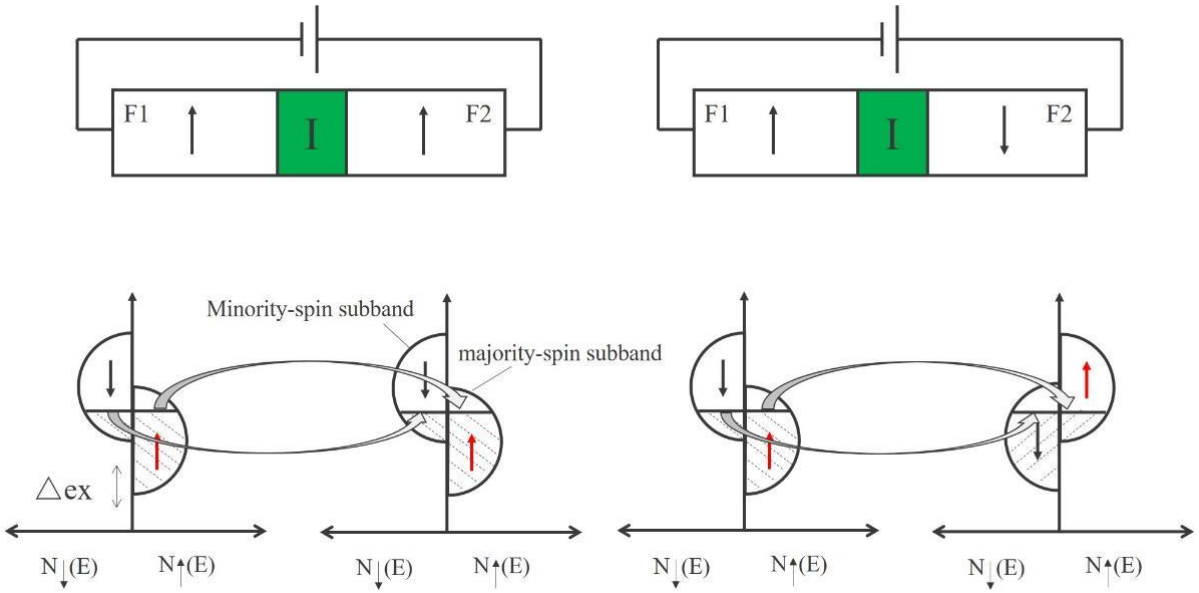
	🔵	⚫	🟢	🟣	🟡
Sensitive to fog and oil		×			×
Probe cillision risk	×			×	
Structural failure	×			×	
Can not bear high temperature		×	×		
Don't resist vibration			×		
Sensitive to environment and airflow			×		×



TMR Magnetoresistive Sensor

- ✓Not sensitive to oil
- ✓Not sensitive to harsh environment
- ✓Probe
- ✓The cage is structurally intact
- ✓High sensitivity
- ✓Anti-vibration
- ✓High temperature resistance

TMR Magnetoresistive Sensor for Bearing Cage Speed Monitoring



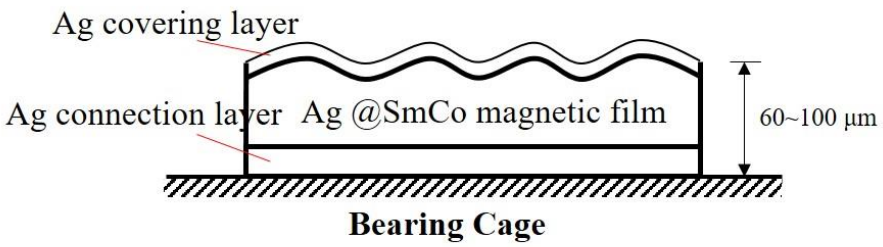
Scheme of quantum tunneling effect of magnetic tunneling junction

Table 1 Physical parameters of magnetic sensors

Technology	Hall	AMR	GMR	TMR
Powder (mA)	5~20	1~10	1~10	0.001~0.01
Size (mm)	1×1	1×1	2×2	0.5×0.5
Sensitivity (mV/V/Oe)	0.05	1	3	20
Range (Oe)	1~1000	0.001~10	0.1~30	0.001~200
Resolution (mOe)	500	0.1	2	0.1
Temperature (°C)	< 150	< 150	< 150	< 200
Response Time (ns)	> 1000	10	10	0.1
Temperature Drift (PPM/K)	3000	3000	3000	400

- Tunnel magneto-resistance (TMR) based on magnetic tunnel junction (MTJ) consists of a thin insulating layer (a tunnel barrier), sandwiched by two ferromagnetic electrode layers.
- TMR magnetoresistive sensor exhibits better properties in comparison with Hall, AMR and GMR sensors.

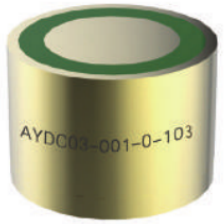
Intelligent Bearing Speed and Vibration Integrated Monitoring



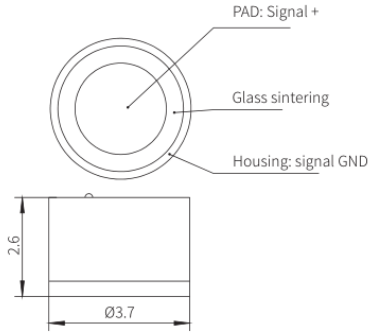
The structure of magnetic film and its optical photo

- Precise control the thickness of the magnetic film via micro-nano processing;
- Strong adhesion;
- High service temperature (240 °C)
- Controllable magnetic information (N and S);
- Weak residual magnetic;
- Non-destructive to bearing cage;
- Miniaturization accelerometer ;
- Embedded installation ;
- Low power and real-time wireless transmission.

MEMS Sensor AYDC03-103



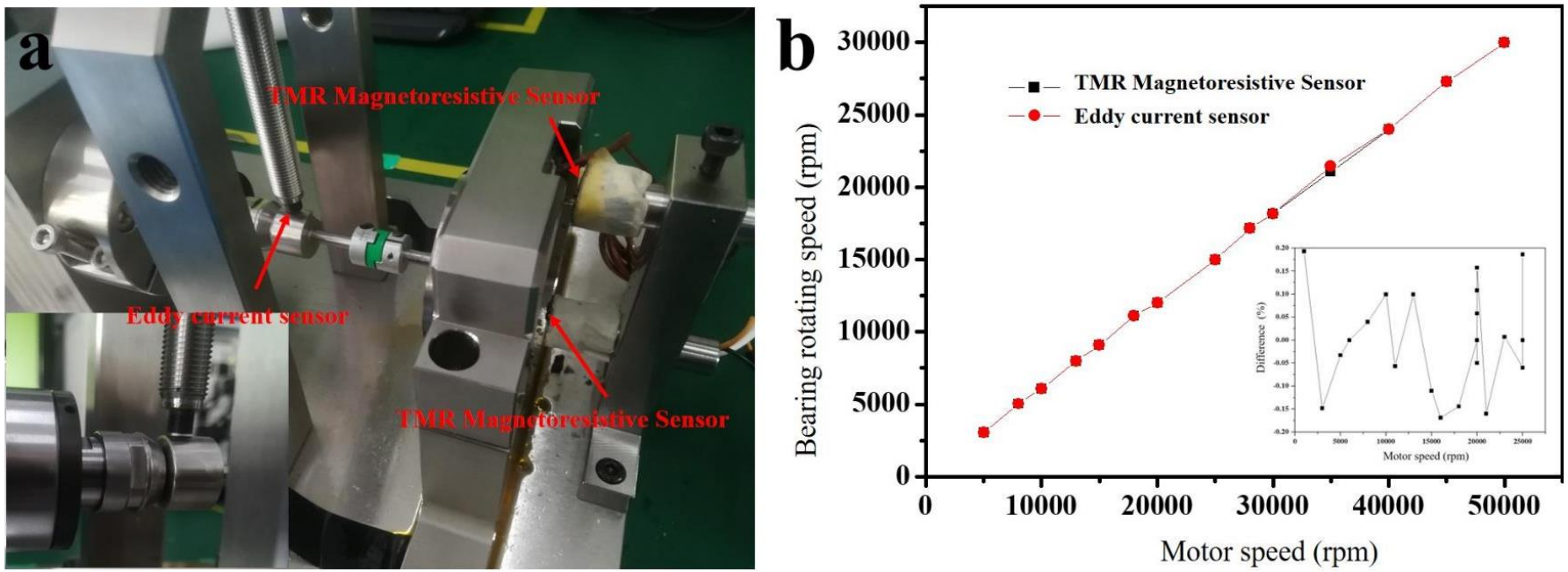
Model: AYDC03-103



Size (Unit: mm)

Dynamic Characteristics	Unit	Value
Sensitivity	mV/g	10±5%
Range	g	±500
Resonance Frequency	KHz	⩾30
Frequency Response Range	Hz	1~5000(±3dB)
Transverse Sensitivity	%	⩽5
Amplitude Nonlinearity	%	⩽1
Electrical Characteristics		
Insulation Resistance	GΩ	⩾1
Bias Voltage	V DC	9~14
Electrical Grounding		Signal Grouding
Environmental Characteristics		
Working Voltage	V DC	18~30
Working Current	mA DC	4~10
Working Temperature	℃	-55~120
	℉	-67~248
Shock Limitation	G pk	5000
Physical Characteristics		
Weight	gram	<1
Outer Case		40Cr Medium Carbon Steel

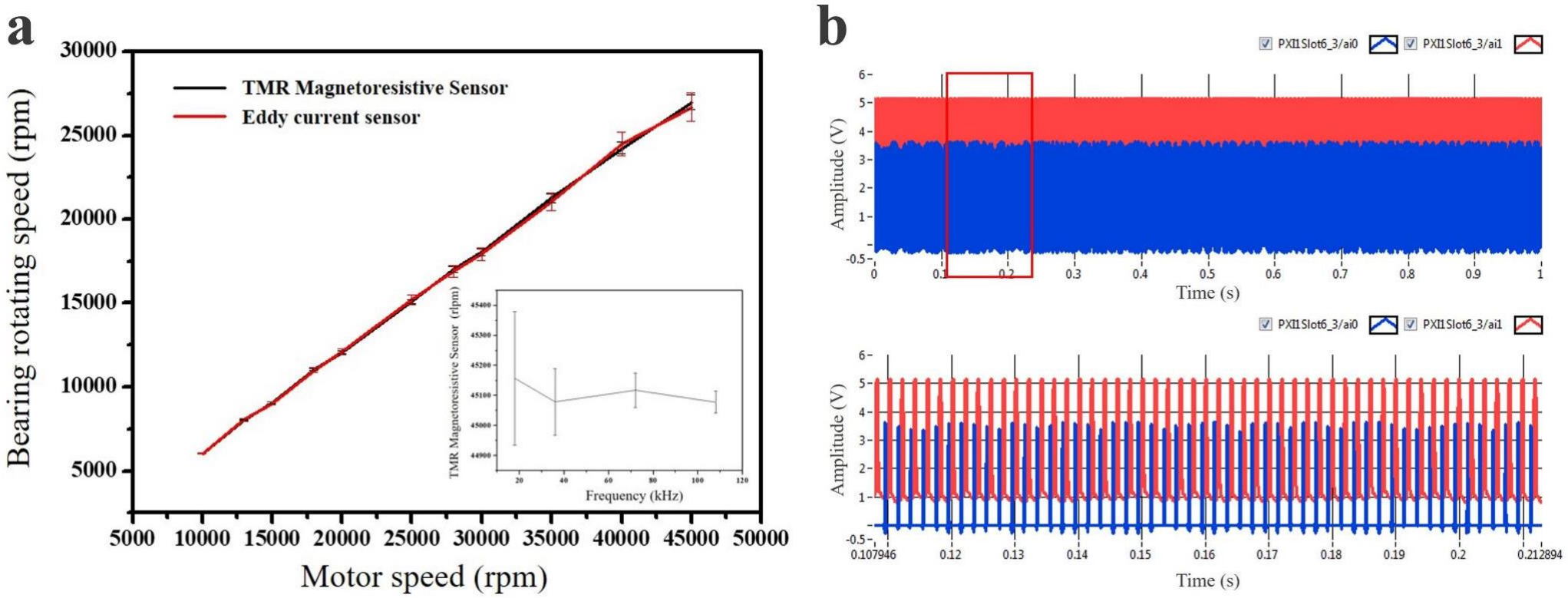
TMR Magnetoresistive Sensor for Bearing Cage Speed Monitoring



Calibration scheme of bearing and cage speed measurement via TMR and eddy current sensor

- The mounting distance of TMR magnetoresistive sensor is about 2.5 mm, while the mounting distance of eddy current sensor is about 1 mm;
- The bearing rotating speed from TMR magnetoresistive sensor exhibits linear relativeship with the motor speed, and the fluctuation is about ± 0.2% compare to eddy current sensor.

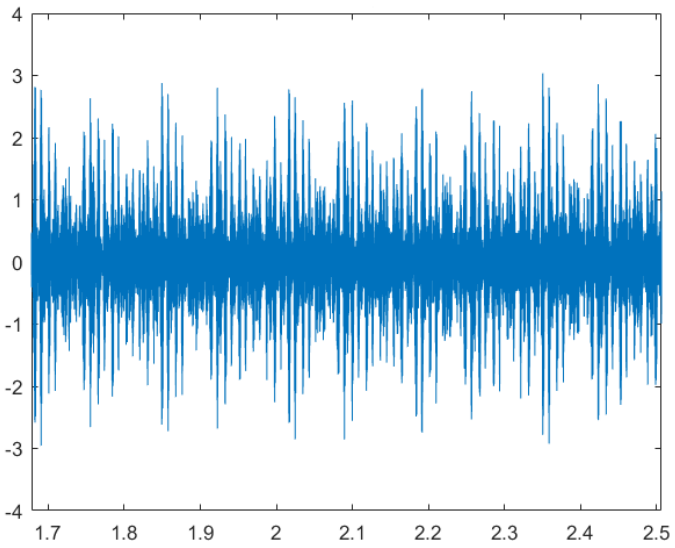
TMR Magnetoresistive Sensor for Bearing Cage Speed Monitoring

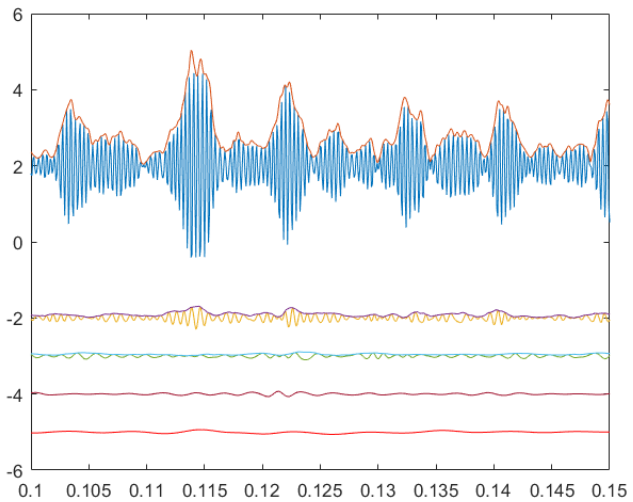


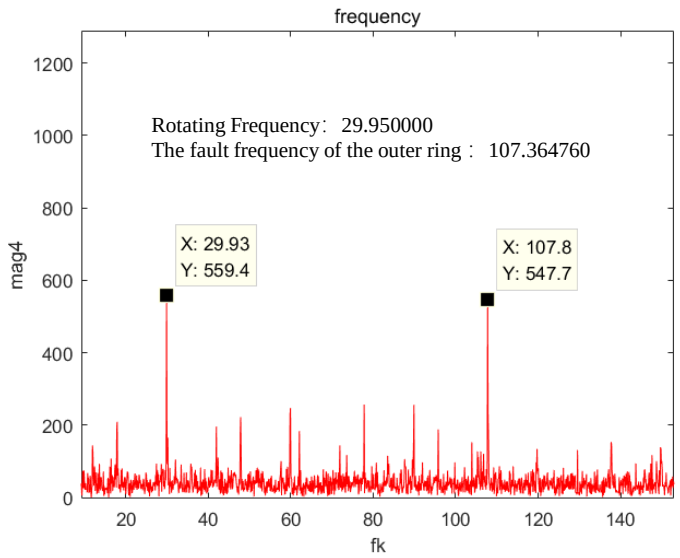
The test difference between the two sensor (a) and the acquisition waveform of the two sensors at 10 kHz (b)

- The measurement fluctuation difference of magnetoresistive speed measuring sensor is smaller than that of eddy current sensor;
- No wave lose was found at a high rotator speed in magnetoresistive and eddy current sensors.

Smart Bearing Vibration Monitoring Experimental Data







(a) Original signal (b) EMMD decomposition and HHT envelopment of Original signal (c) Spectrum of EMMD-IMF4 Envelopment

THANKS FOR

WATCHING!

For more product information, please visit www.fatri.cn, or contact our sales representative.

Email address: fatri@fatri.cn, Phone: 400-668-6967

STATEMENT

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Road-Map

1st African Digital Summit
25-27 February 2019

CES
January 2019

DIGIM II
May 2019

UIC Digital Days
3-4 October 2019

Launching DIGIM III
October 2019

UIC Digital Conference
10 December 2019

UIC Digital Awards
10 December 2019

Progress paper

2019 — 2020

2020

CES
January 2020

UIC Conference, Brussels
February 13th

DIGIM III

2nd African Digital Summit
April

UIC ASIA-PASIFIC Conference on Digital
14-15 May

End of DIGIM II
May 2020

HIGH SPEED CONFERENCE
30June-3July 2020

UIC Digital Conference And UIC Digital Awards
December 2020

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BulldozAIR

Platform for construction project management

Ali El Hariri
CEO, Co-Founder, BulldozAIR
contact@bulldozair.com

BulldozAIR

Expertise in constructiontech and software

FOUNDERS

Ali El Hariri – CEO – Ex Manager in Bouygues
Maxence Lerigner – CTO – Digital Entrepreneur

KEY DATES

- 2012 Founded, 2016 US incorporation
- 2015 Seed investment, 2019 Series A

KEY NUMBERS

- 15 people
- +30 big account clients

Key partnerships

- Investors : Y Combinator (USA), SETEC, Kima Ventures - Xavier Niel, Pascal Casanova (Lafarge)
- Incubators : Impulse Partners, UBI France, BNP

CBINSIGHTS Le Monde LE MONITEUR.fr Les Echos
STATION F TechCrunch Y Combinator france•tv

Common projects in rail industry

Train stations

Infrastructure

Projects

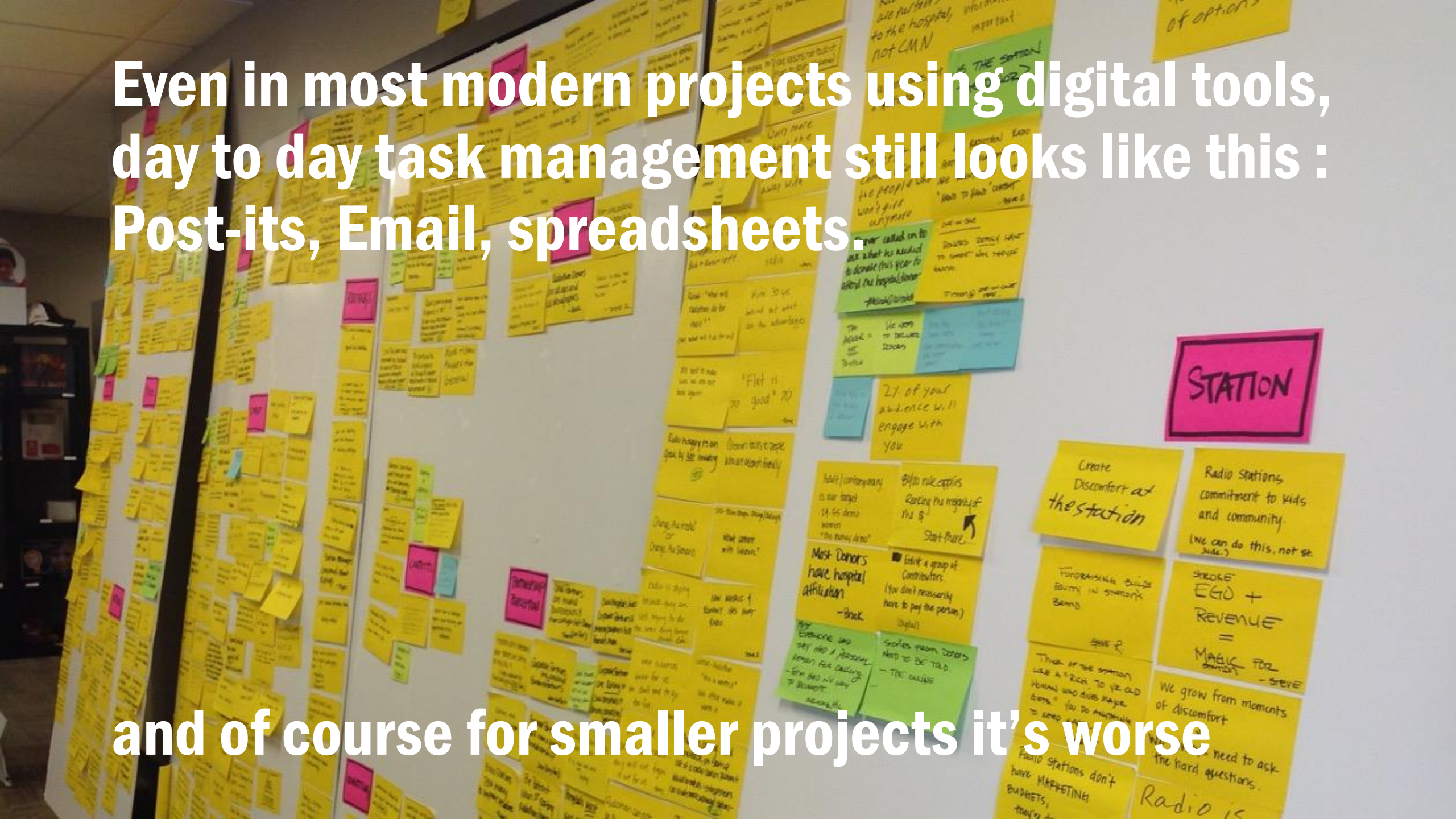
Ongoing

Construction

Refurbishment

Re-habilitation

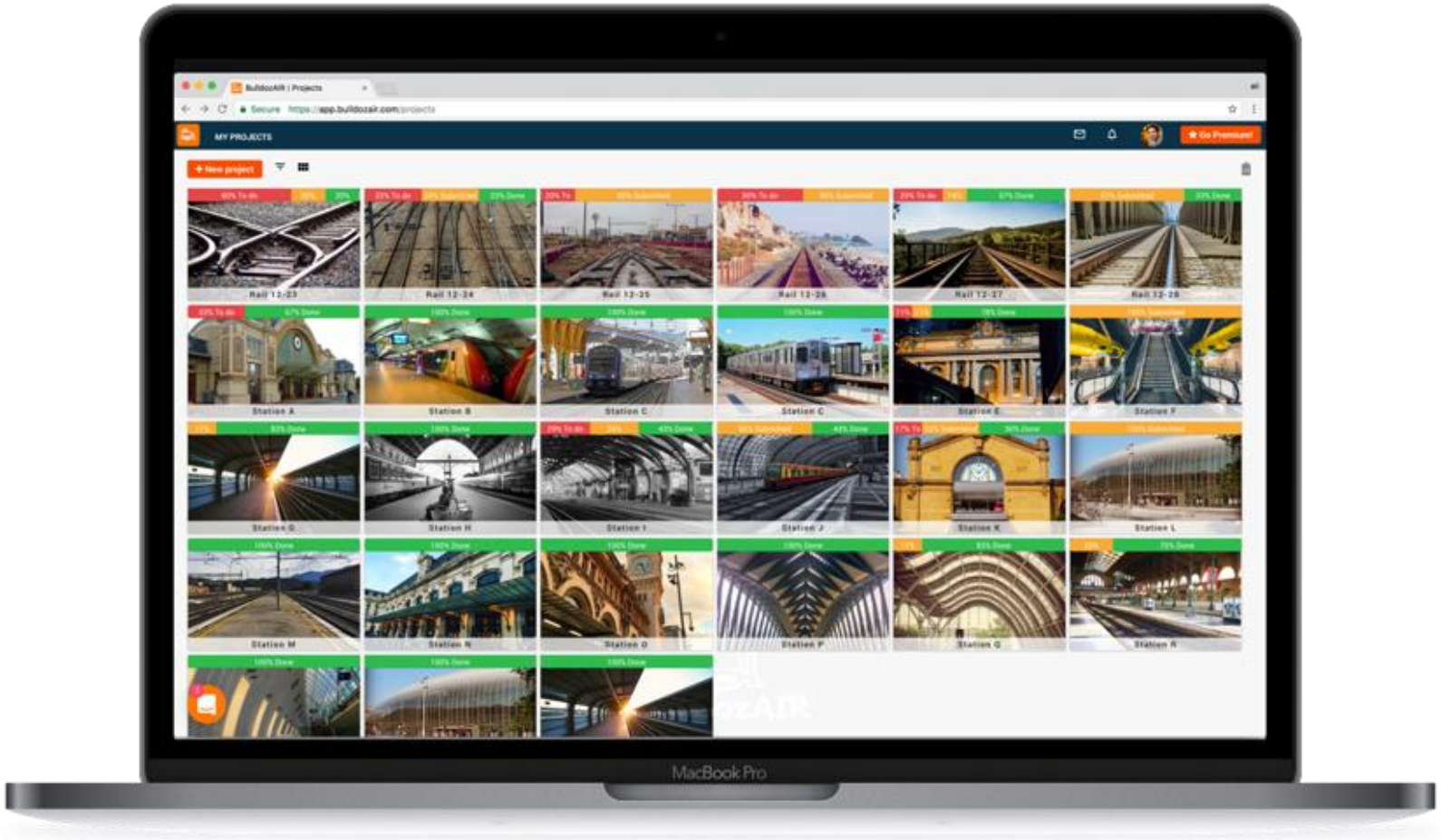
Maintenance



Even in most modern projects using digital tools, day to day task management still looks like this : Post-its, Email, spreadsheets.

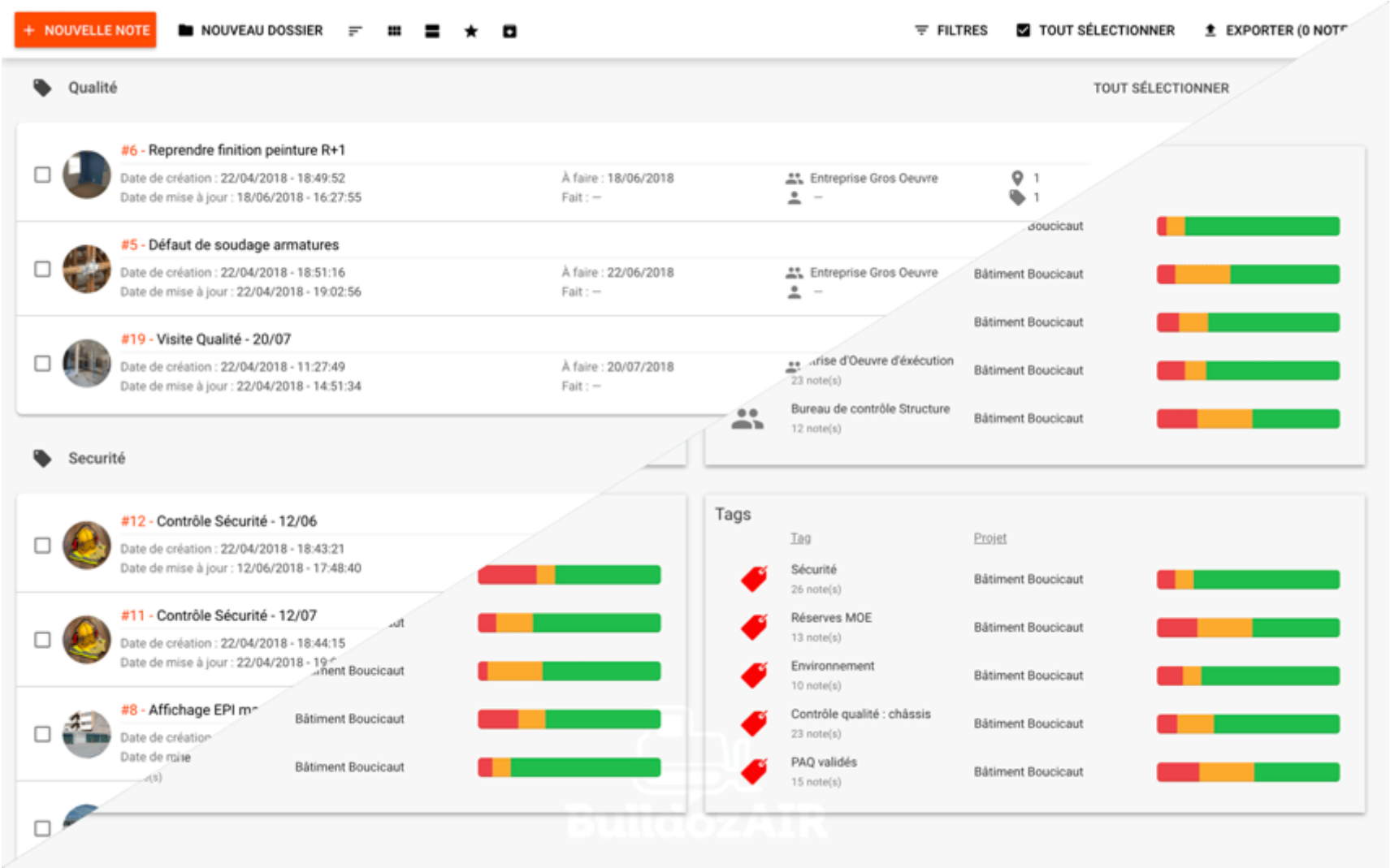
and of course for smaller projects it’s worse

So we built BulldozAIR :
An easy to adopt and all-in-one platform for project management



BulldozAIR at the office

A clear view of construction projects from the office

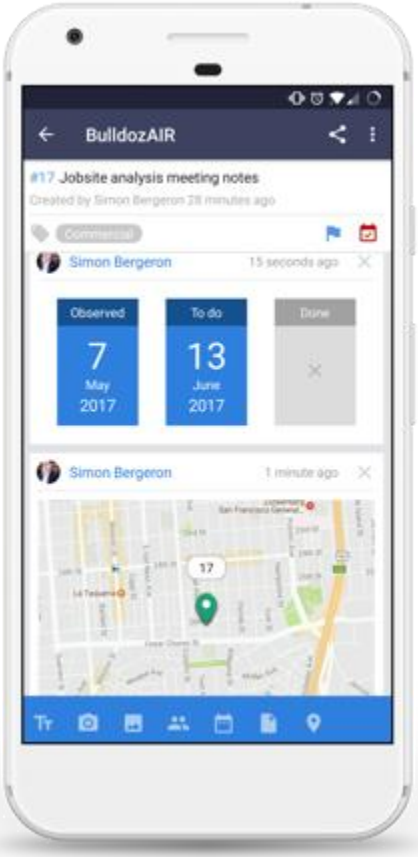


BulldozAIR on the field

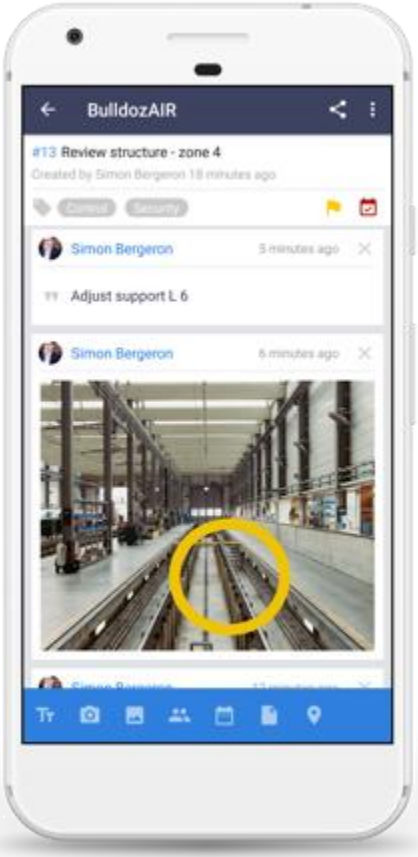
Mobile information gathering, even offline

Project management

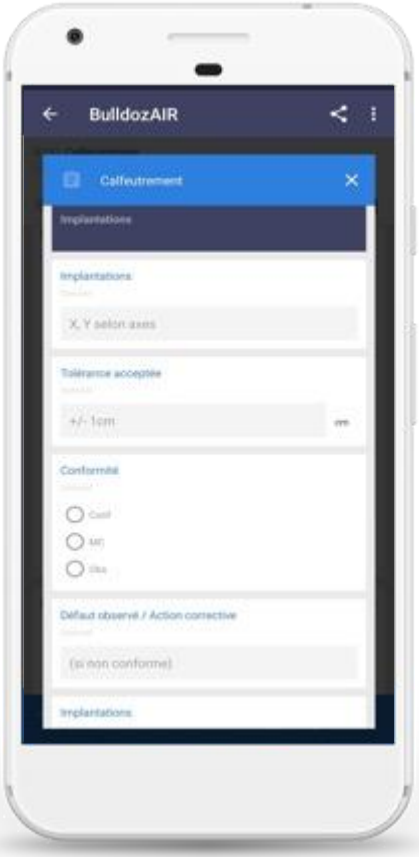
Localization
Geolocalization



Planning
Notifications



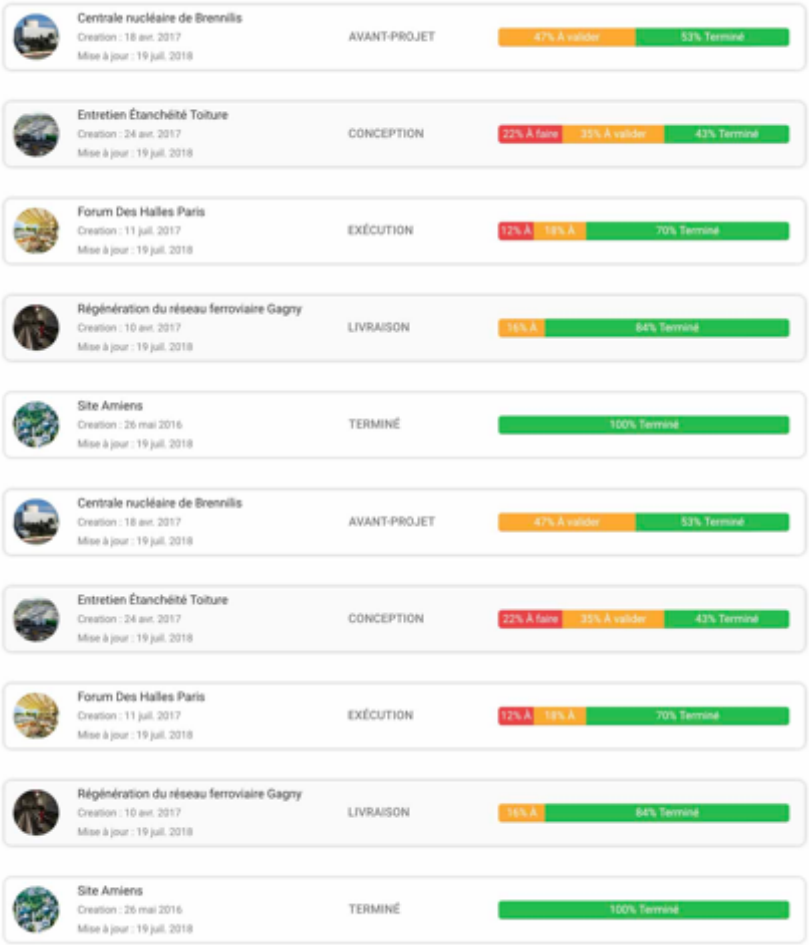
Photos
Works tracking



Forms
Documents

Traceability and monitoring

The gathered information are analysed, distributed and formatted automatically

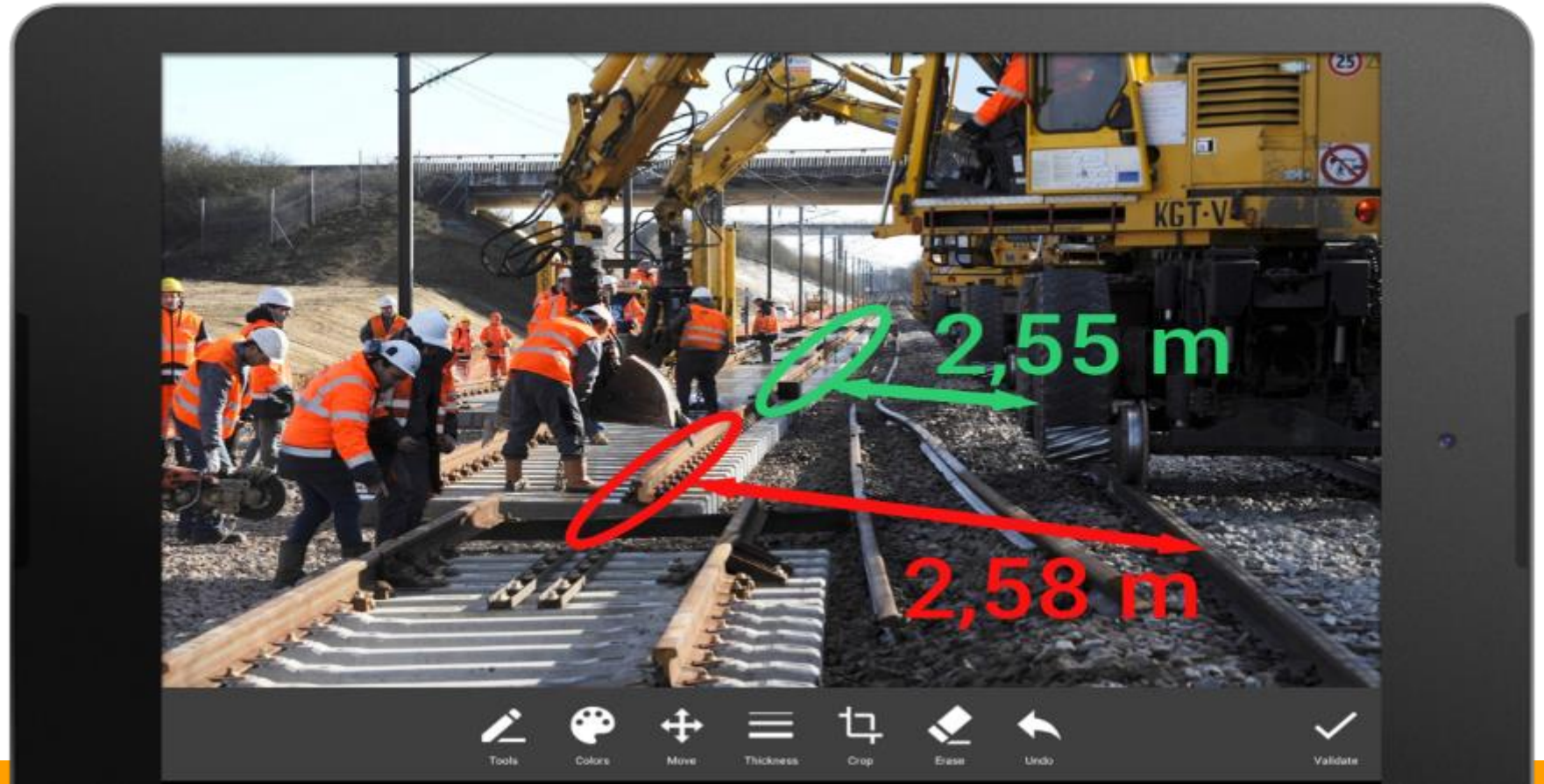


Dashboard

Automated reporting

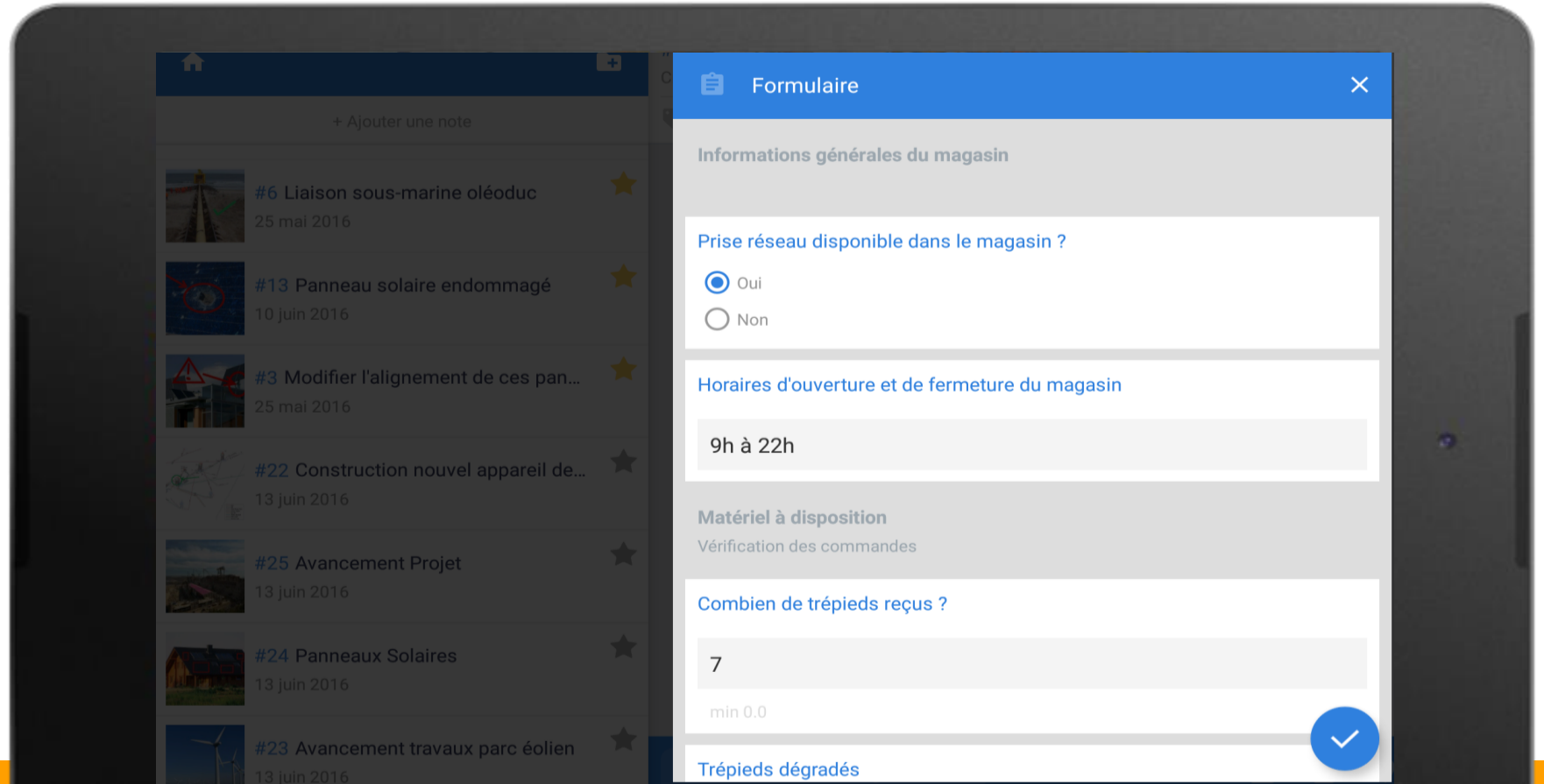
#1 Takes pictures and draw

Collect information on field, even off line



#1Bis Fill technical forms

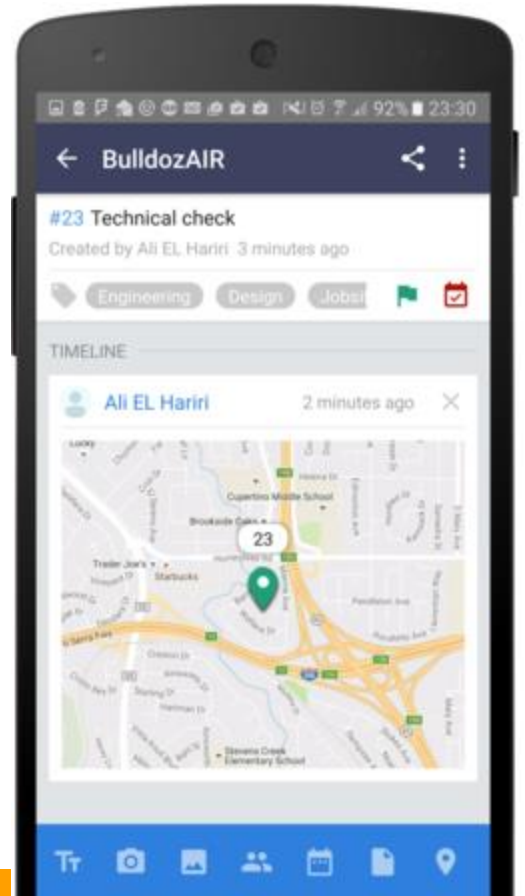
Collect information on field, even off line

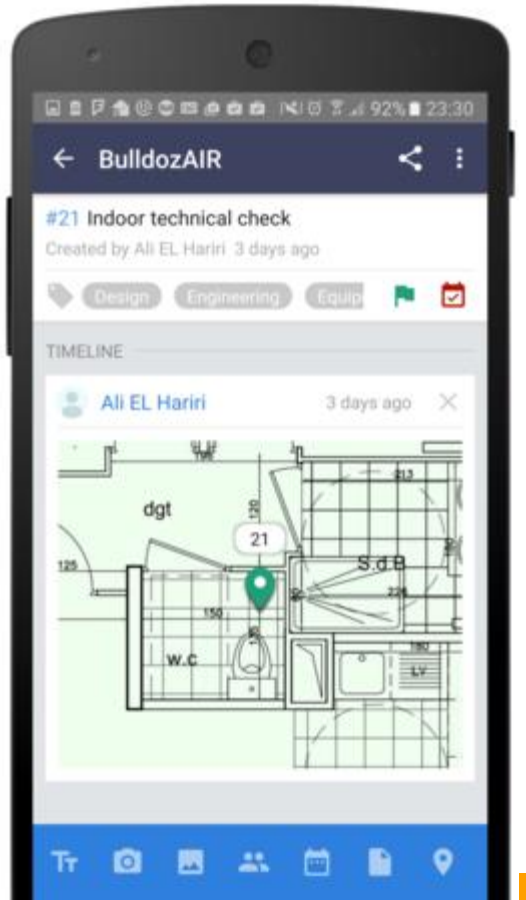


#2 (Geo)Locate your tasks

Locate on plans or geolocate all your field observations

Geolocation

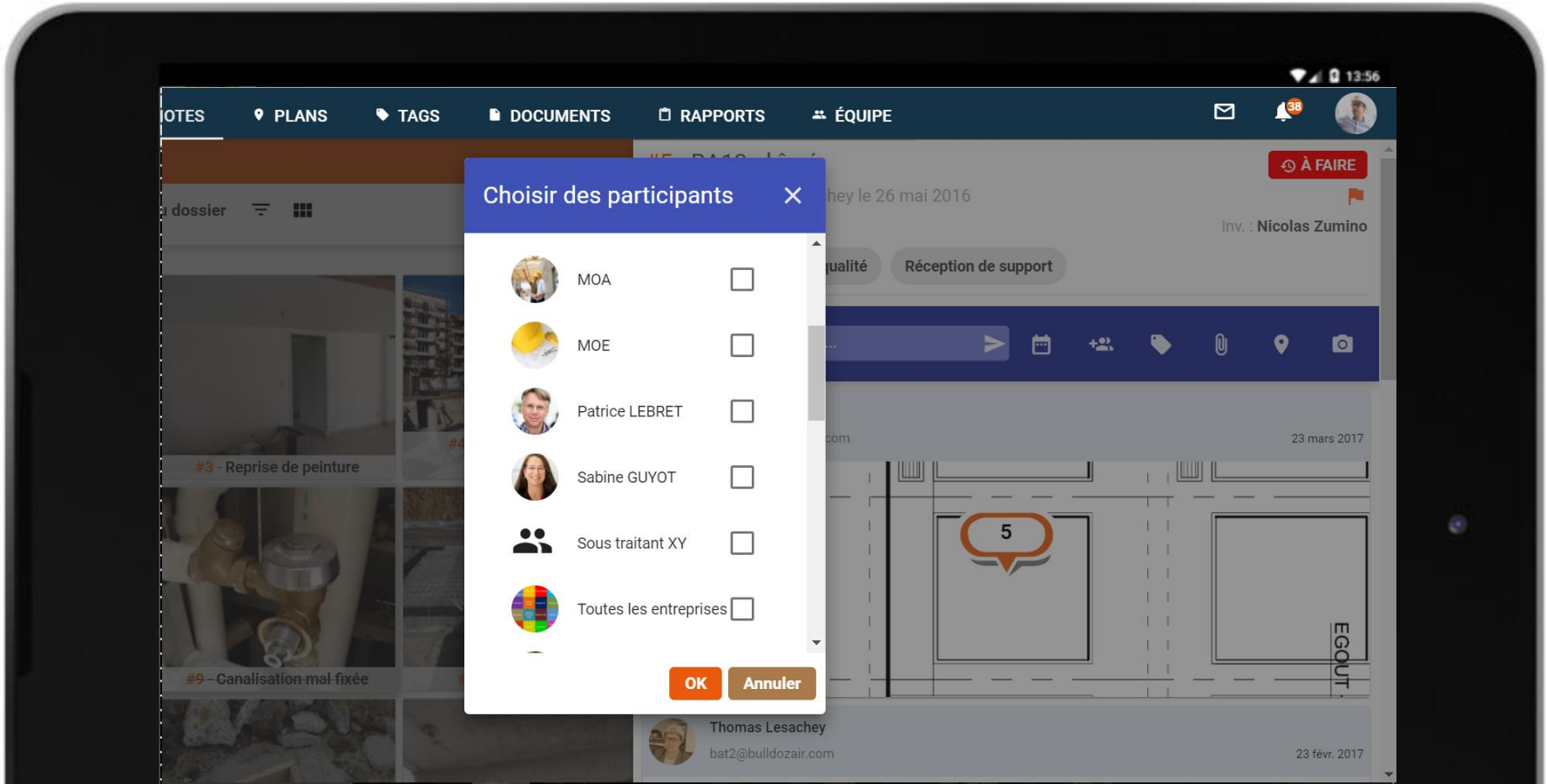




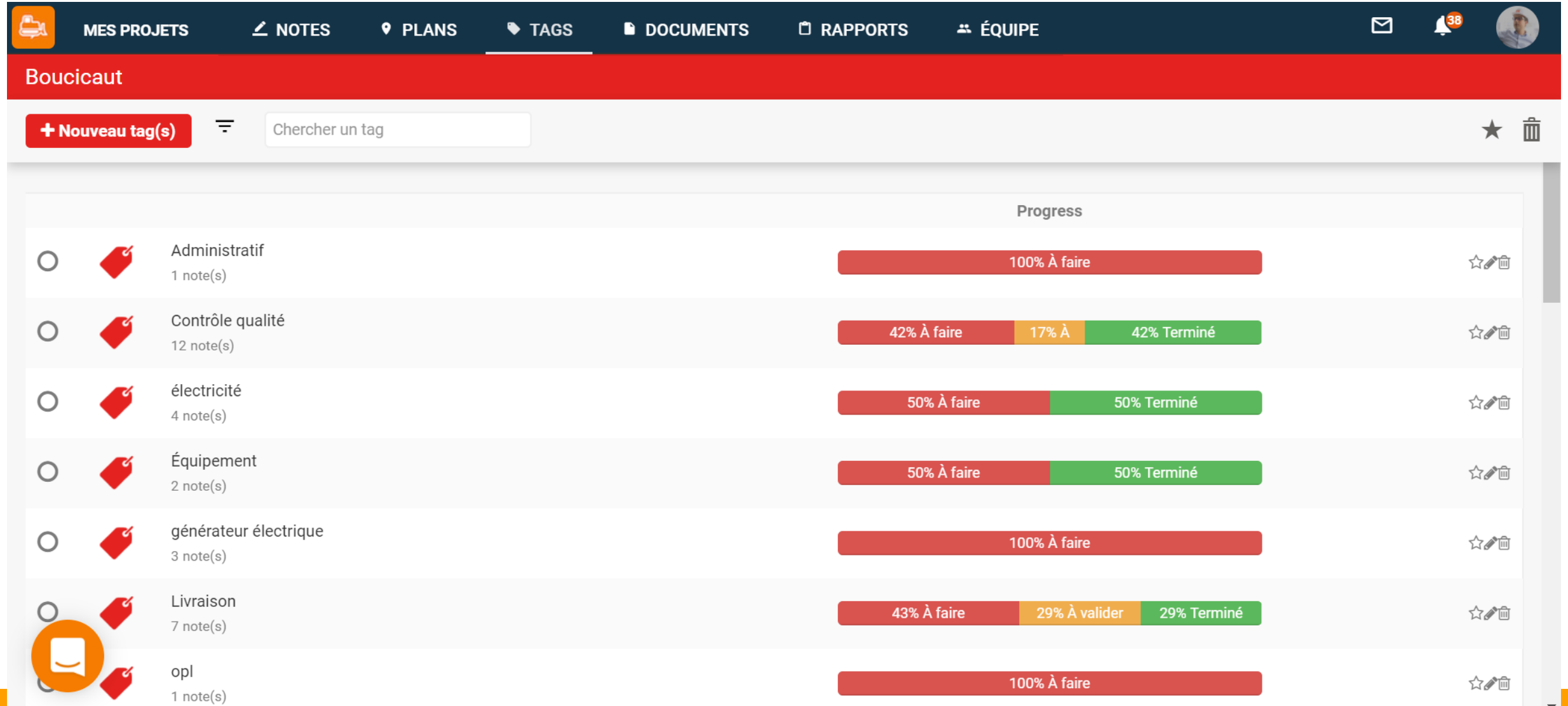
Location on plan

#3 Collaborate with everyone on the project

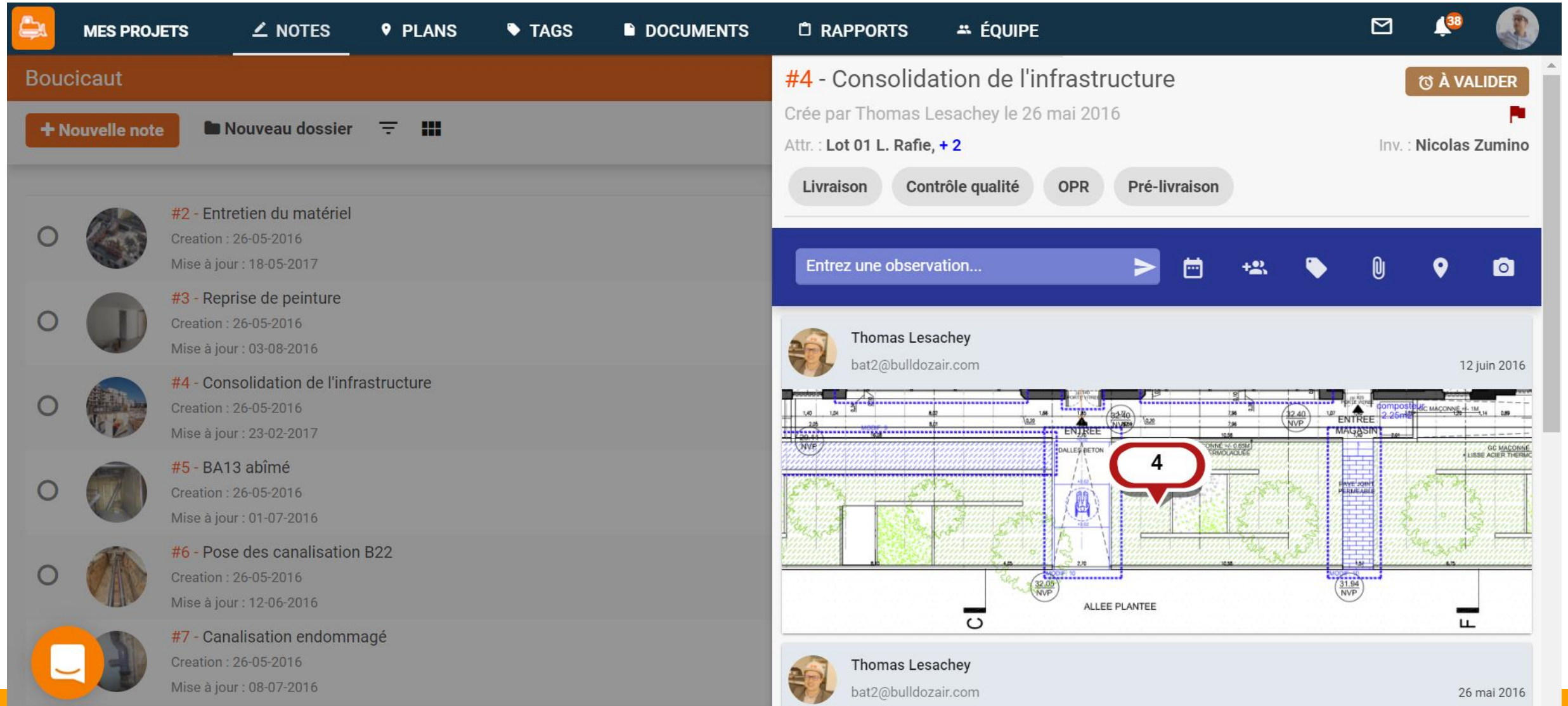
Attribute precise tasks to a specific project member



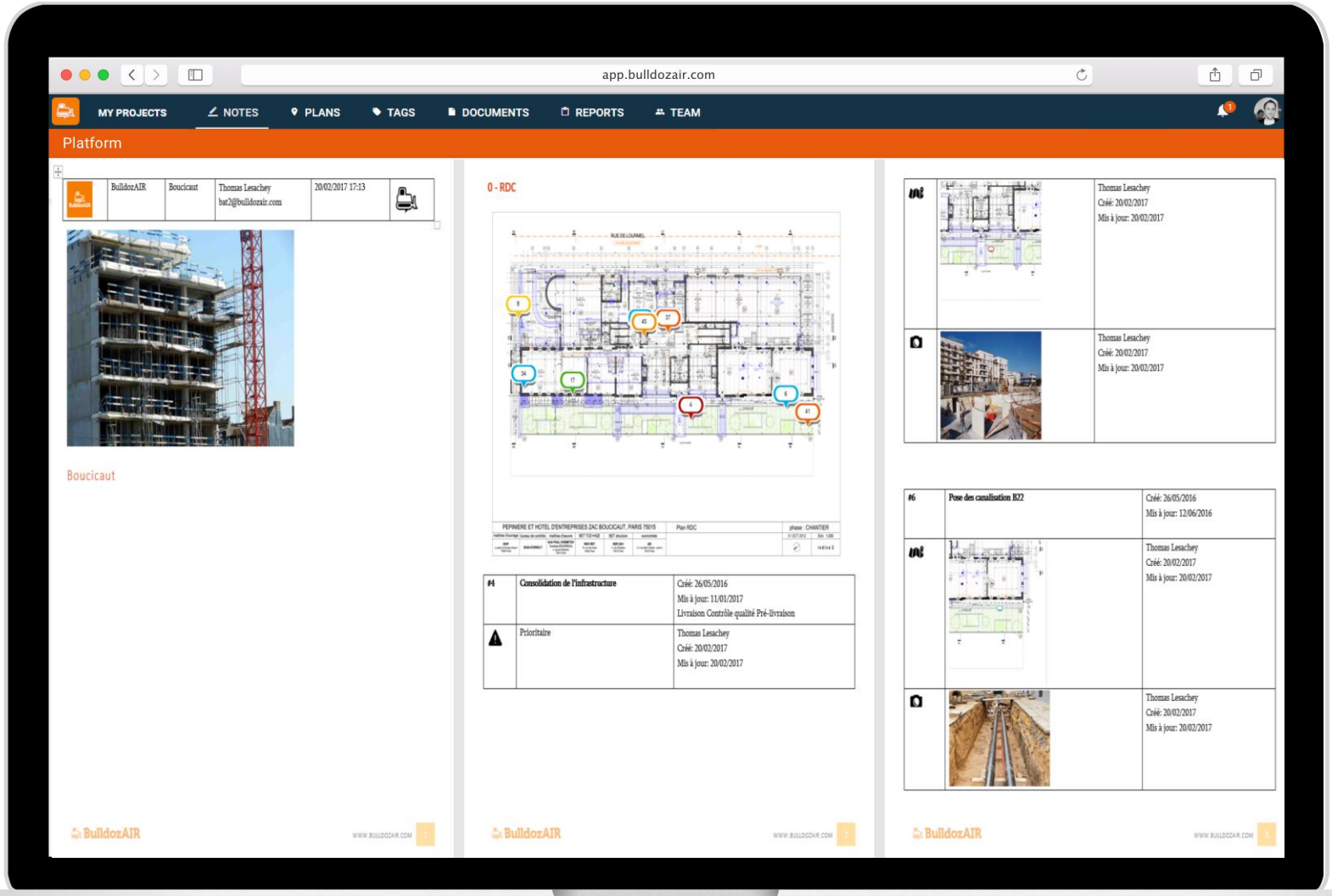
#4 Back to office – Back to Data



#5 Monitor your projects



#6 Automaically generates report



Once you leave the field, your report is ready.

Benefits

A strong interest for every project member

Project Manager

- Global view of project
- Traceability and monitoring of actions
- Standardization of processes
- Notifications

General contractor, Project Manager Assistant, Design Office

- Reduced visitation time
- Automated reporting
- Enhanced monitoring

Companies, Contractiors

- Clear list of tasks to carry out
- Access to all documents and plans

Use cases

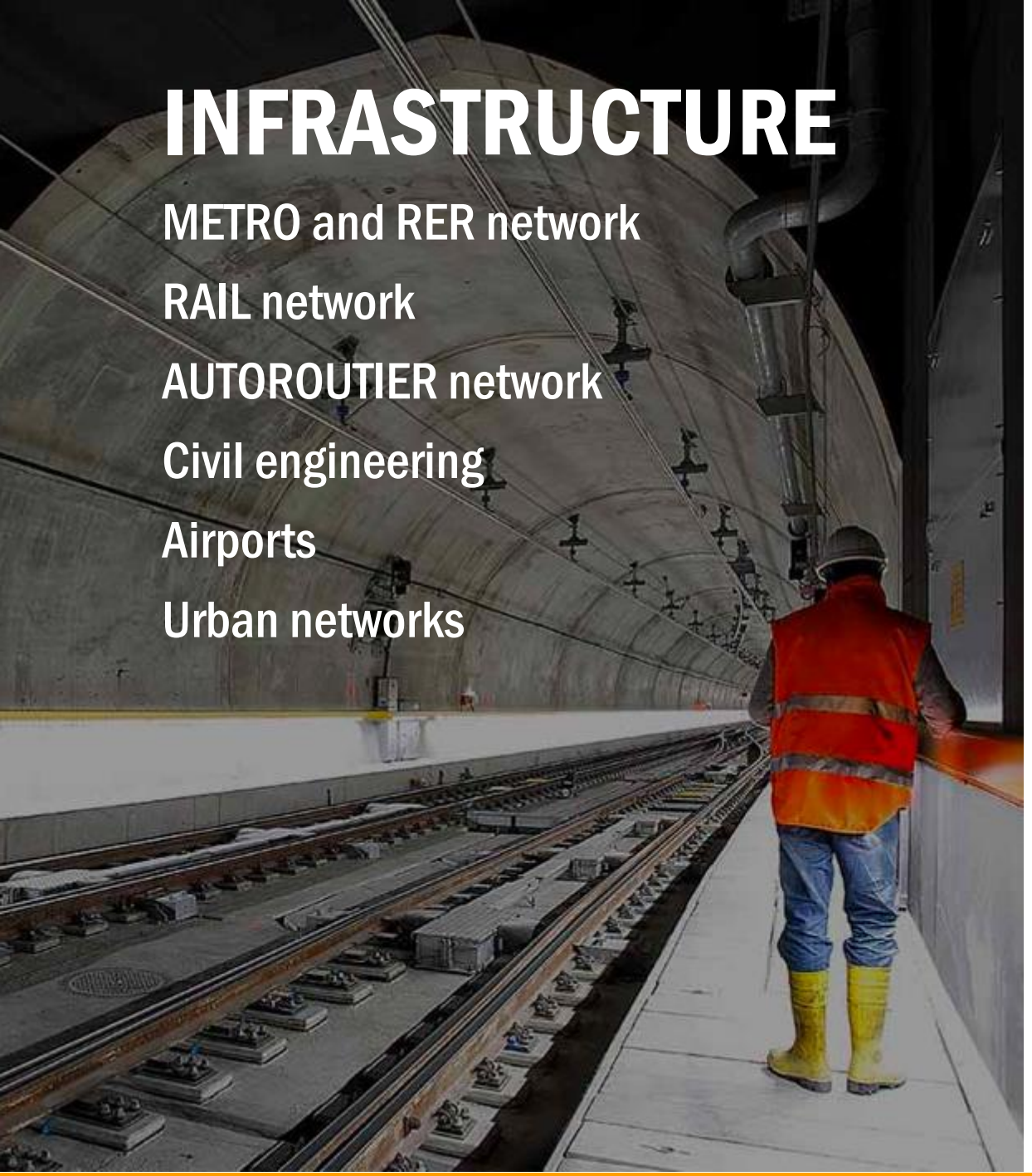
Scope of use of BulldozAIR : project management from A to Z

Pre-project	Project	End of project	Post - project
Initiation	**Execution**	**Punch list review**	**Exploitation**
Control plan Inventory / inspection Site audit Milestone tracking	Follow - up and management of progress Site meeting	Proof of invoiced services Traceability Record of finished work	Tracking of works On-site interventions

Our clients

Owning or operating real estate or industrial assets

Their partners



INFRASTRUCTURE

METRO and RER network

RAIL network

AUTOROUTIER network

Civil engineering

Airports

Urban networks

RATP

GROUPE ADP

SNCF

Société du Grand Paris

setec

suez environnement

VINCI

SYSTRA

INGÉROP Inventons demain

ENGIE

APRR

EUROVIA VINCI

Some references in Infrastructure and transports

Prolongement du Tram T3

Paris

Longeur : 4,3 kilomètres

Donneur d'ordre : Mairie de Paris

Maîtrtise d'oeuvre : SETEC

Budget : 211 millions d'euros

Prolongement de l'autoroute A16

L'isle-Adam-Frontière Belge

Longeur : 8 kilomètres

Donneur d'ordre : Sanef

Maîtrtise d'oeuvre : Setec

Budget : 210 millions d'euros

Projet Férroviaire Contournement Nîmes-Montpellier

Nîmes-Montpellier

Longeur : 80 kilomètres

Donneur d'ordre : Oc'Via

Maîtrtise d'oeuvre : SETEC

Budget : 1,757 milliards d'euros

BulldozAIR

PROGRAMME

*UIC digital Awards 2019 (*Presentations of their projects by the selected startups)

- Bulldozair — Services Category
- Cylus — Safety Category
- National Engineering Laboratory — Productivity Category
- Supraways — Special Prize

- Digital Awards ceremony
- Conclusion by François Davenne

10 December 2019
UIC HQ, PARIS

Intelligent Operation and Maintenance System of High-speed Railway Permanent Way Based on Big Data

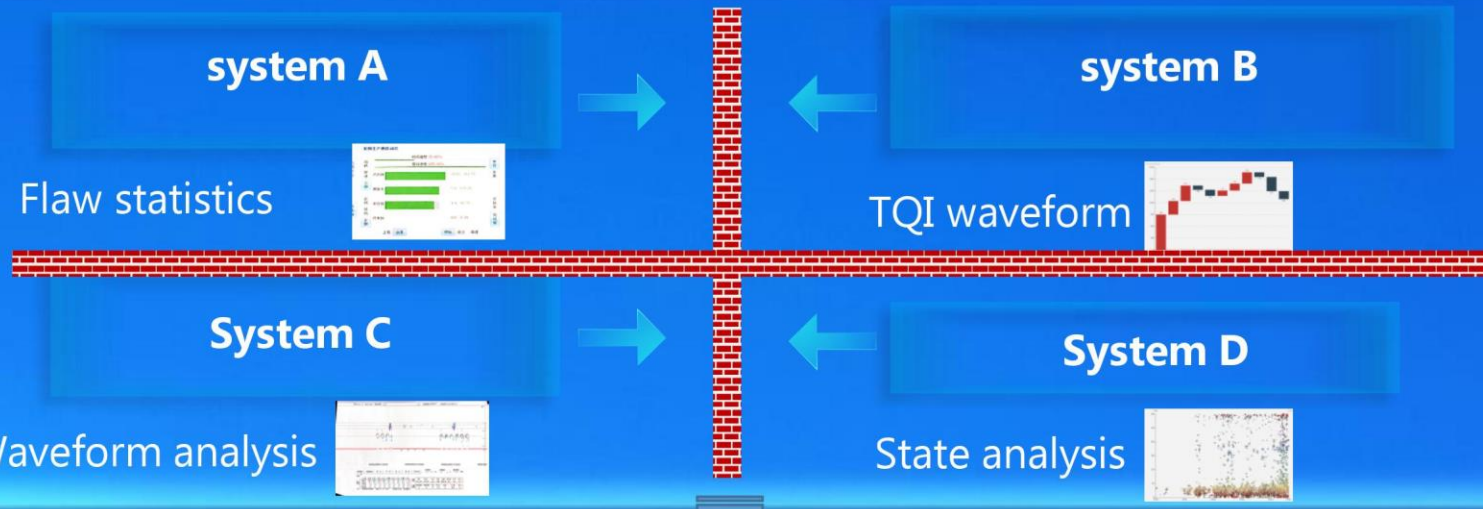
National engineering laboratory of comprehensive transportation big data application technology

Agenda

1 Deeply mining data value using big data and AI technology to improve operation and maintenance productivity

Separate data analysis,

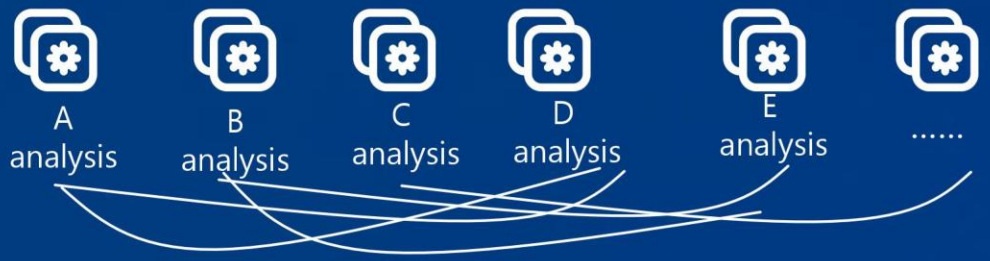
Only 10% of the data value is mined



Apply of big data and AI technologies,

The hidden 90% of the data value is mined

Intelligent Operation and Maintenance System for High-speed Permanent Way Based on Big Data



2 Overall optimization plan

Datalink Management ❯ **Data Intellectualization** ❯ **Law and Trend** ❯ **Assistance and Decision-making**

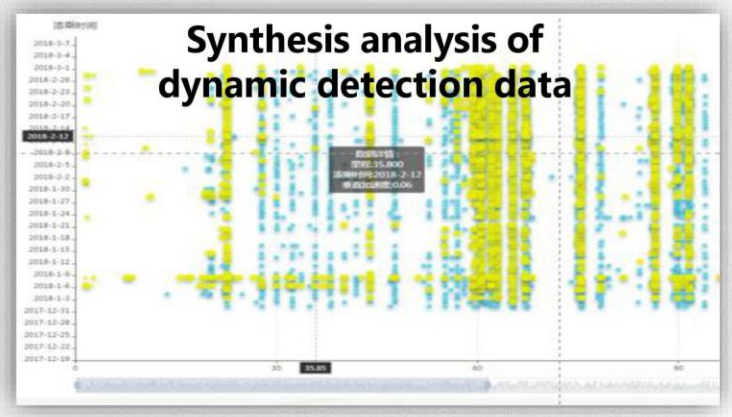
Intelligent Operation and Maintenance System for High-speed Railway Permanent Way Based on Big Data

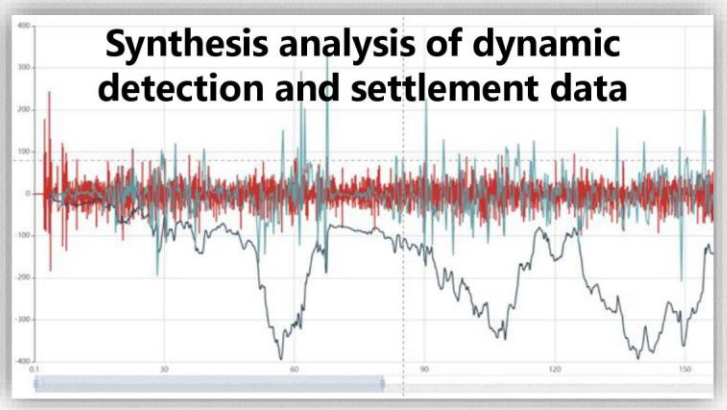
Sensor | Paper report | Professional data | Local data | Mileage data | Image and video | Related records

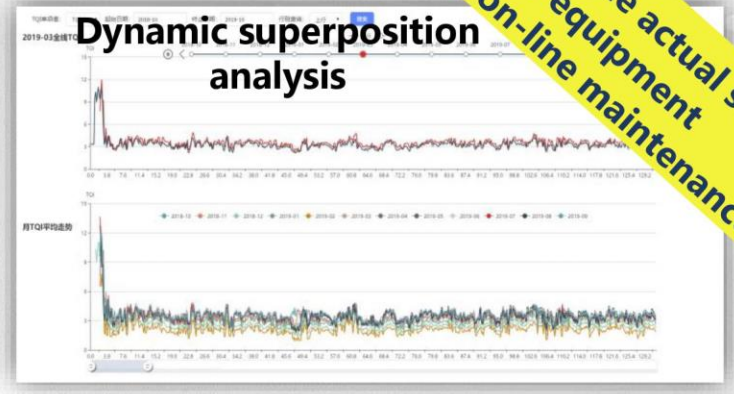
Meteorological | Disaster prevention | Ground settlement | Through gross weight

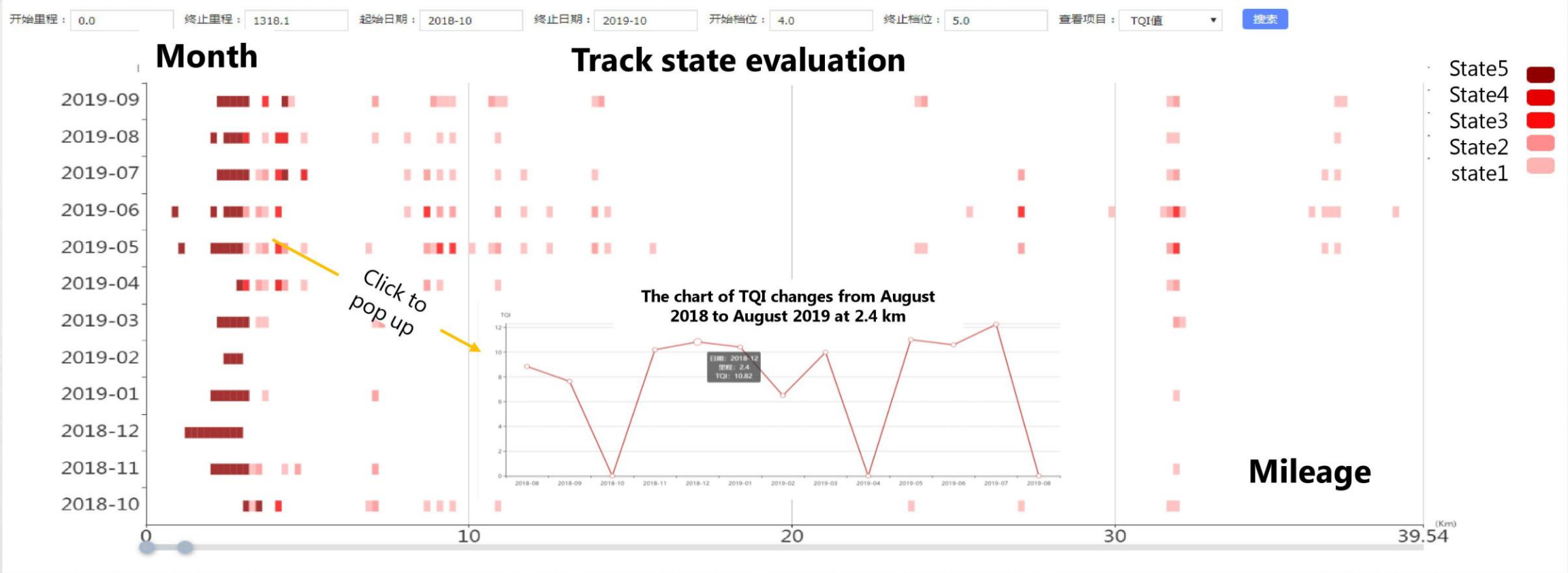
2.1 State evaluation of permanent way equipment based on whole datalink

Evaluate the actual state of equipment
Guide on-line maintenance



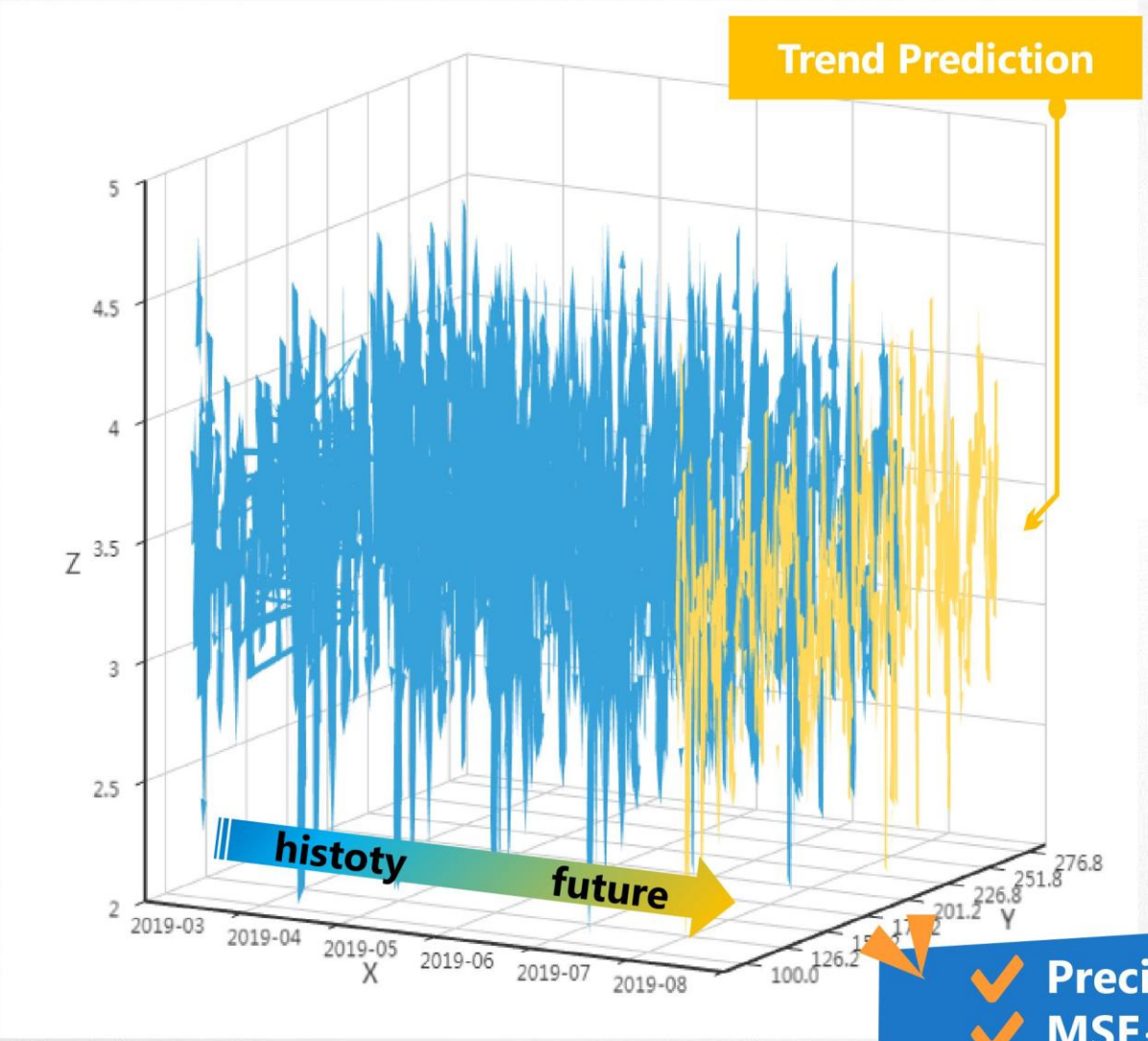


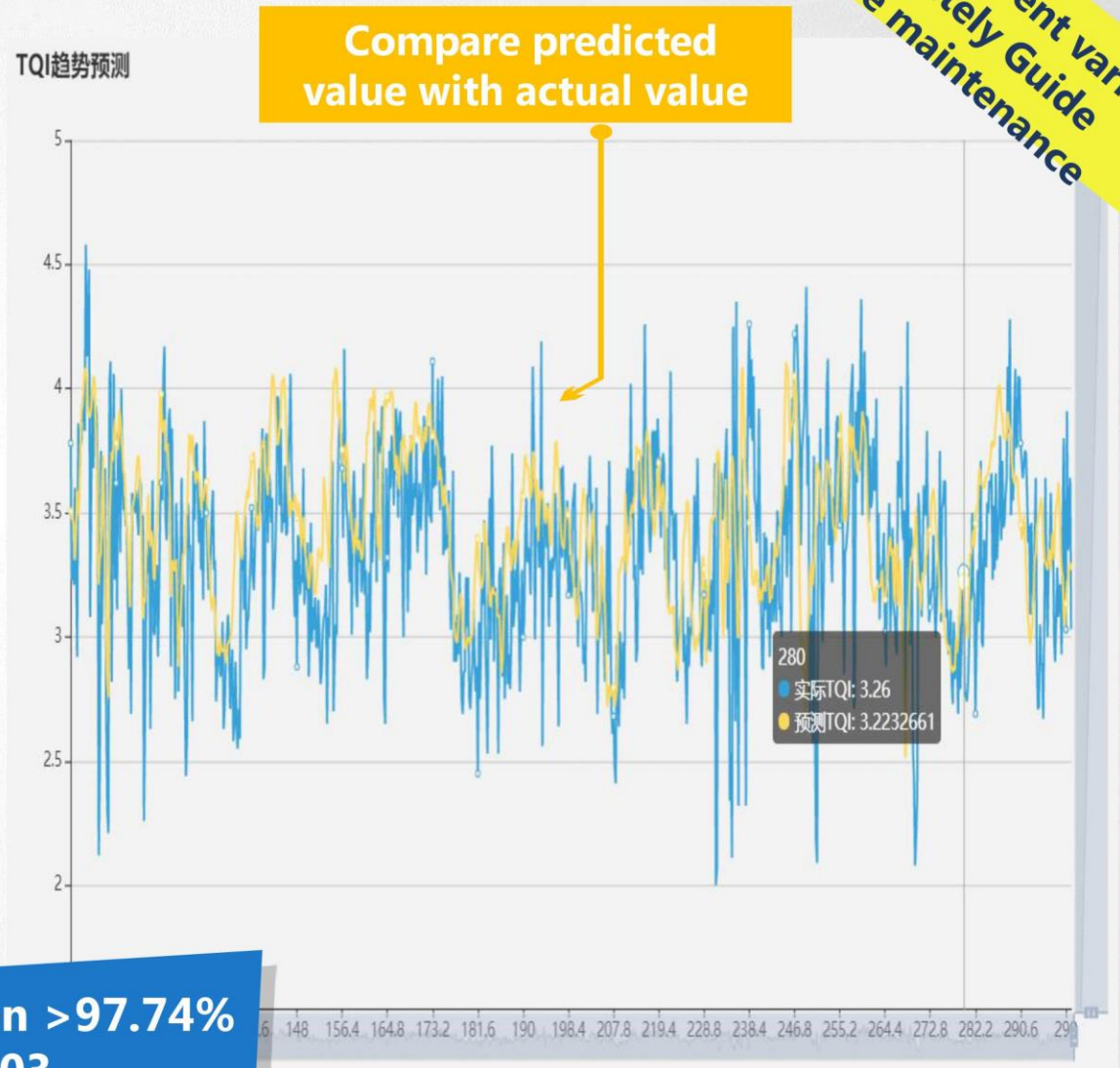




2.2 Prediction of equipment variation trend based on big data

Predict Equipment variation trend accurately Guide preventive maintenance

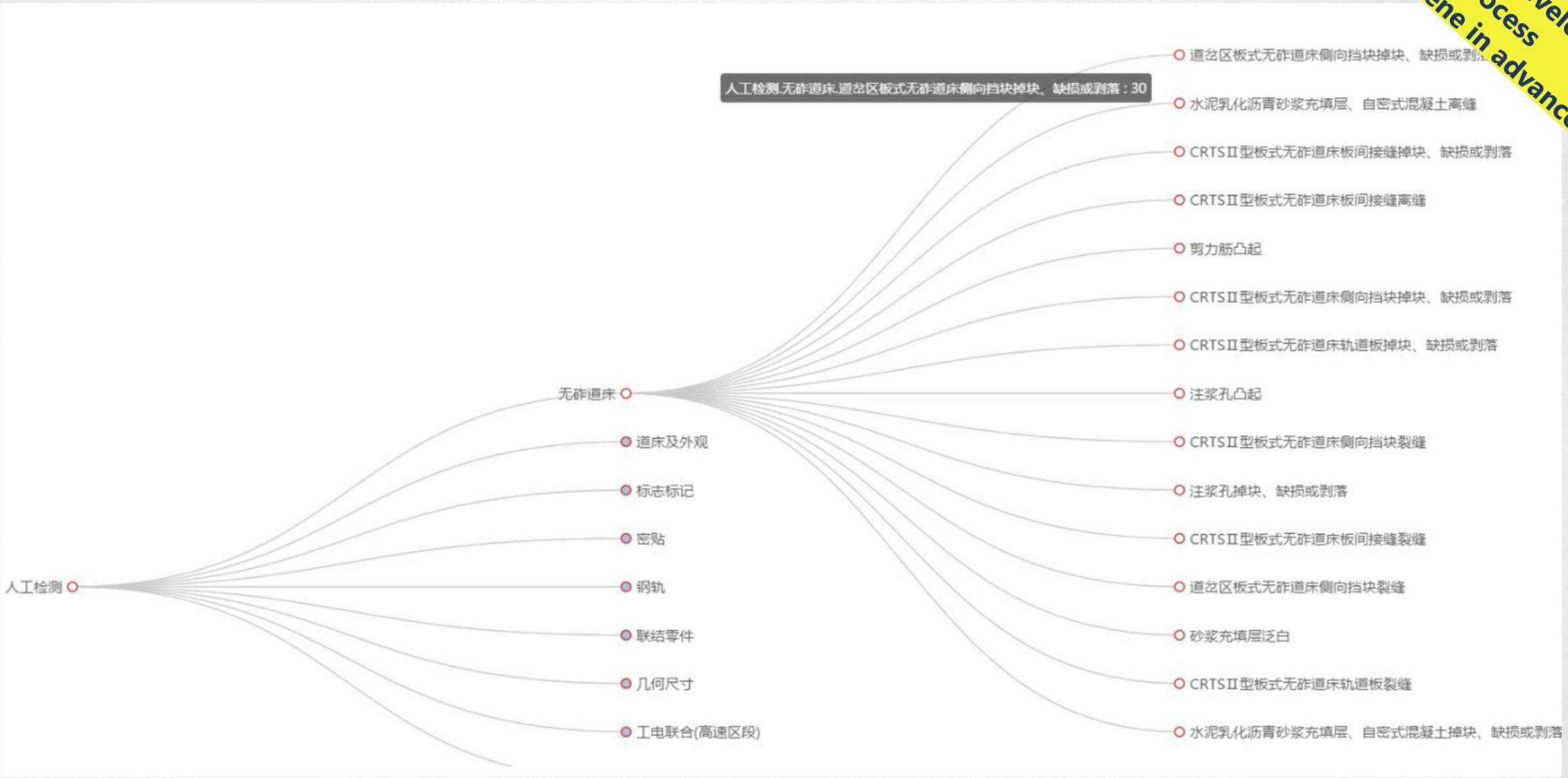




- Precision >97.74%
- MSE<0.03

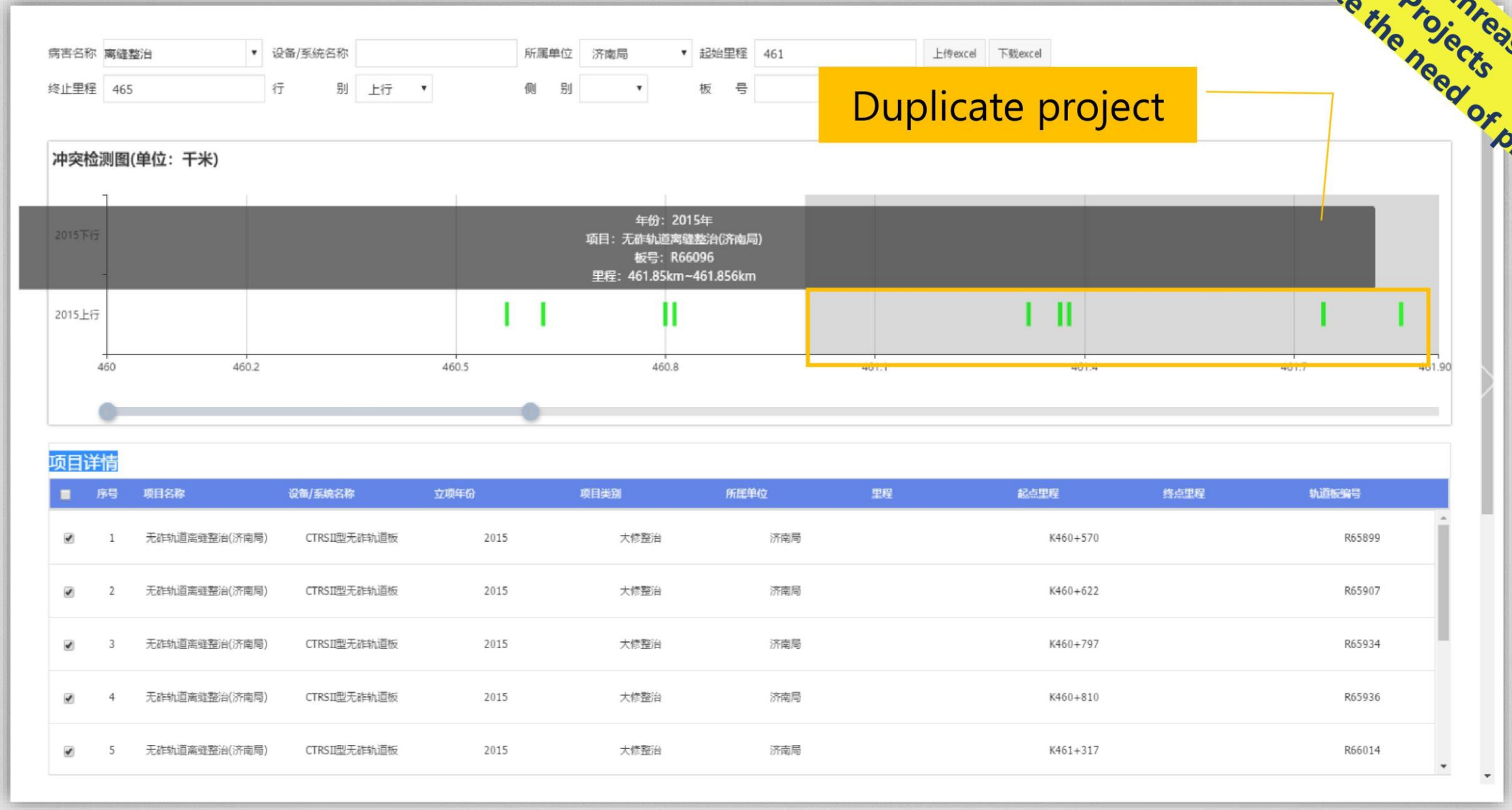
2.3 Flaw classification and correlation knowledge graph of permanent way

Reveal flaw development process
Intervene in advance



2.4 Decision making of project approval and budget estimate of permanent way renewal and overhaul project

Discover unreasonable Projects
Indicate the need of project

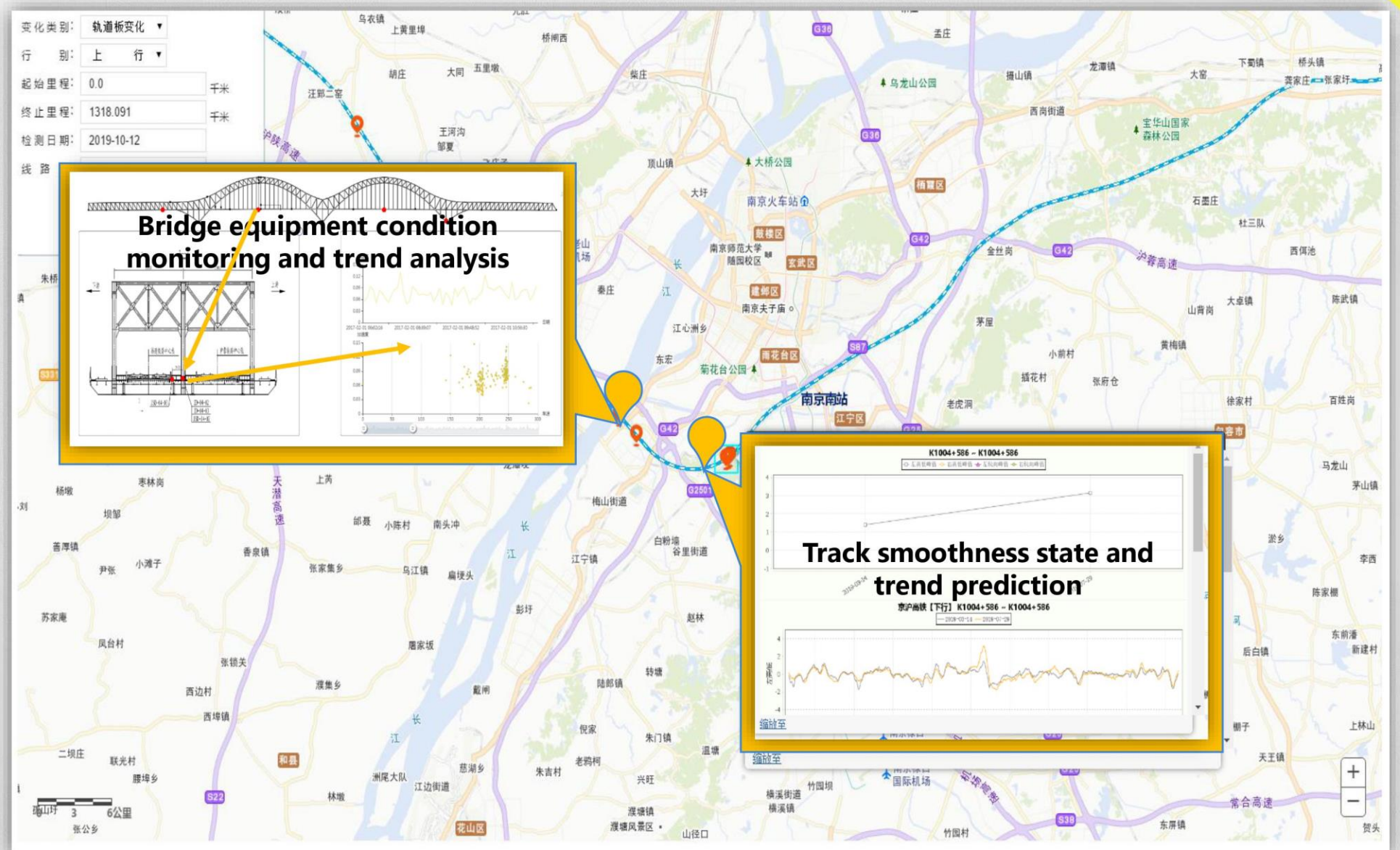


序号	项目名称	设备/系统名称	立项年份	项目类别	所属单位	里程	起点里程	终点里程	轨道板编号
1	无砟轨道离缝整治(济南局)	CTRSII型无砟轨道板	2015	大修整治	济南局		K460+570		R65899
2	无砟轨道离缝整治(济南局)	CTRSII型无砟轨道板	2015	大修整治	济南局		K460+622		R65907
3	无砟轨道离缝整治(济南局)	CTRSII型无砟轨道板	2015	大修整治	济南局		K460+797		R65934
4	无砟轨道离缝整治(济南局)	CTRSII型无砟轨道板	2015	大修整治	济南局		K460+810		R65936
5	无砟轨道离缝整治(济南局)	CTRSII型无砟轨道板	2015	大修整治	济南局		K461+317		R66014

2.5 Recognition and display of abnormal change of permanent way equipment based on electronic map

Intuitive display
Precise positioning

Mileage coordinates + **Call map service**



3. System application effect

Significant improvement

After System Application

- Data quality has been significantly improved. Distributed processing has **increased data processing time by nearly five times.**
- It supports full-type data retrieval, and its retrieval efficiency has been **improved by nearly a thousand times.**

- The accuracy of equipment state estimation is **increased from 82% to 90.**
- The decision time is compressed **from a few hours down to a few minutes**.

Our Team:

National engineering laboratory of comprehensive transportation big data application technology

Focus on big data application technology for integrated transportation (especially railways) to solve transportation decision problems.

Team Members:

Wang Tongjun,Li Ping,Wu Yanhua,Ma Xiaoning,Cheng Zhibo,Zhao Xinxin,Dai Chunping,
Zhao Zhengyang,Zheng Jinzi,Xiao Xin,Feng Boqing,Liu Yanjun,Dai Mingrui,Wu Wei,Xu Wenya

PROGRAMME

*UIC digital Awards 2019 (*Presentations of their projects by the selected startups)

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- Cylus — Safety Category
- National Engineering Laboratory — Productivity Category
- Supraways — Special Prize

- Digital Awards ceremony
- Conclusion by François Davenne

10 December 2019
UIC HQ, PARIS

UIC Digital Awards 2019

SUPRA WAYS
Fly in your city

Smart urban mobility

Autonomous, rapid & sustainable

FRENCH MOBILITY

La FRENCH TECH

City expectations in a hyper-urbanization context

Endless
urban growth

> 50% → > 70%

Congestion & pollution
records

Under-performing conventionnal
public transit modes

**Limited resources
for the planet and the cities**

→

**Sustainable transportation
needs**

Smart cities need smart and sustainable urban mobility !

Supraways: a sustainable public transit mode for passengers and freight

Network of interconnected loops, no waiting time

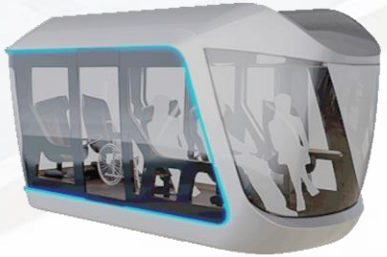
Aerial mode, free ground space, fast prefabricated construction

Off-line stations, Direct trips

On-demand Trips, 24/7

V2X communication system Smart fleet management

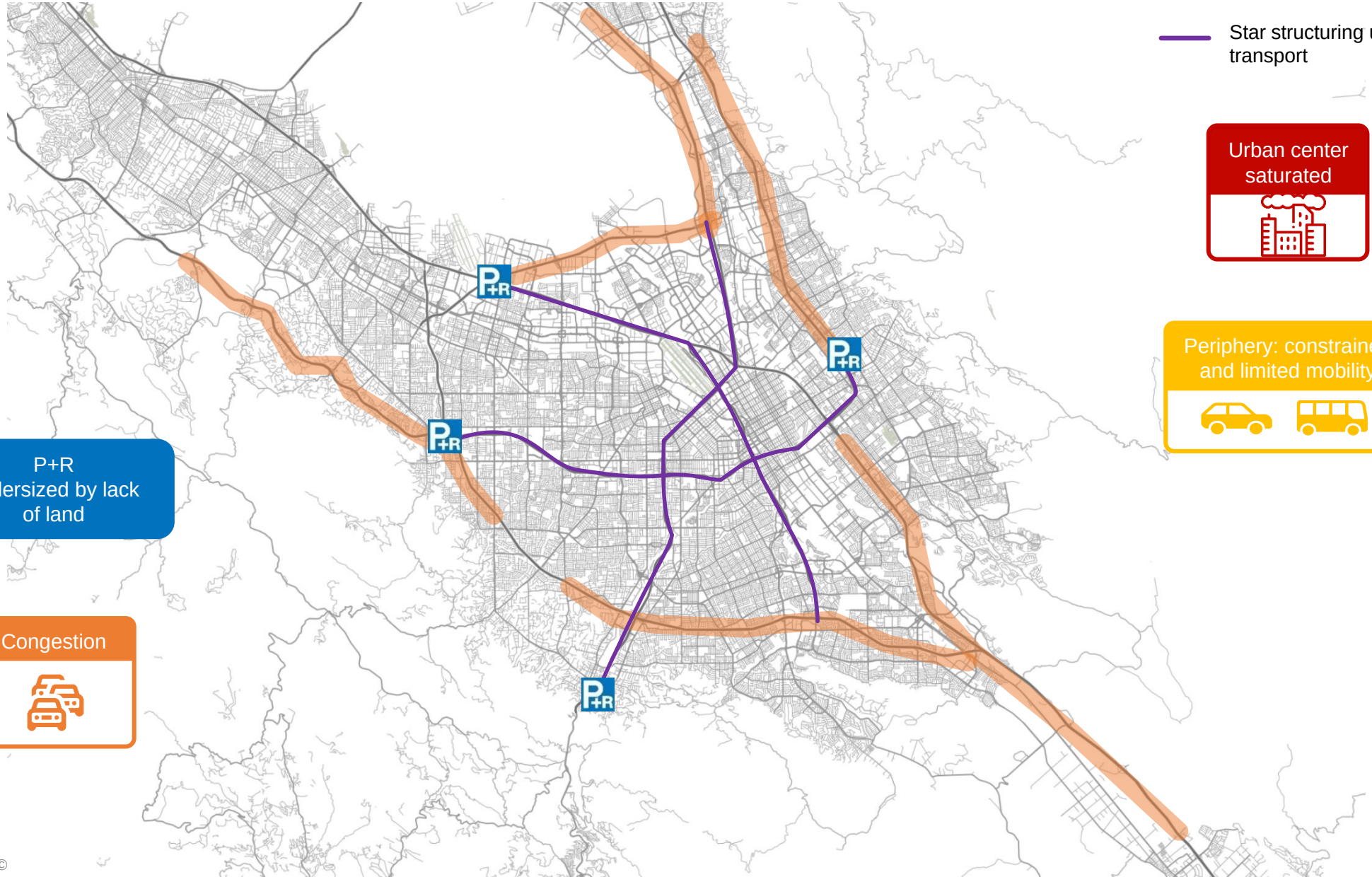
Electric vehicle
Clean energy



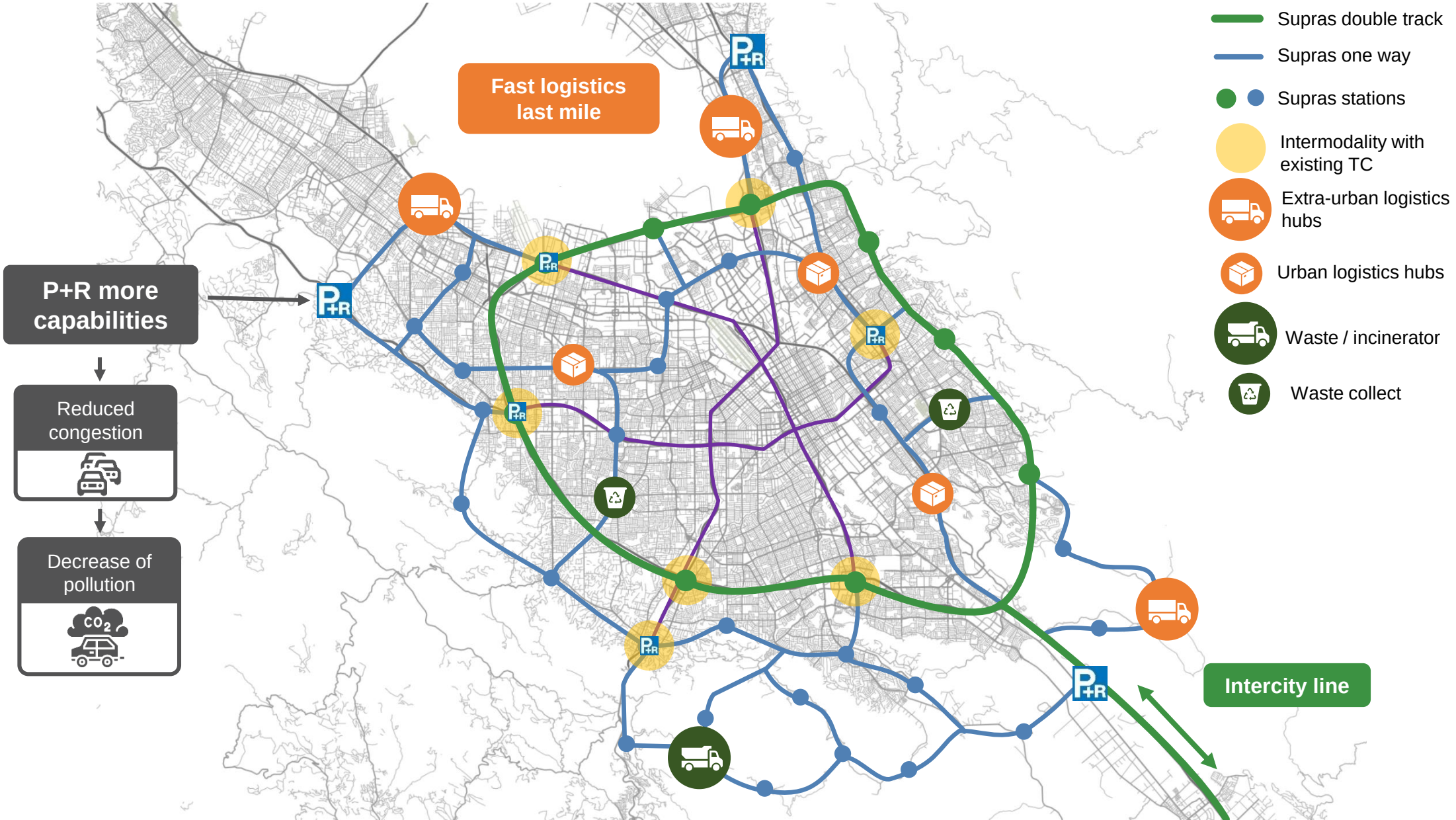
Passenger vehicle
7-9 passengers

Freight vehicle
1,5 t

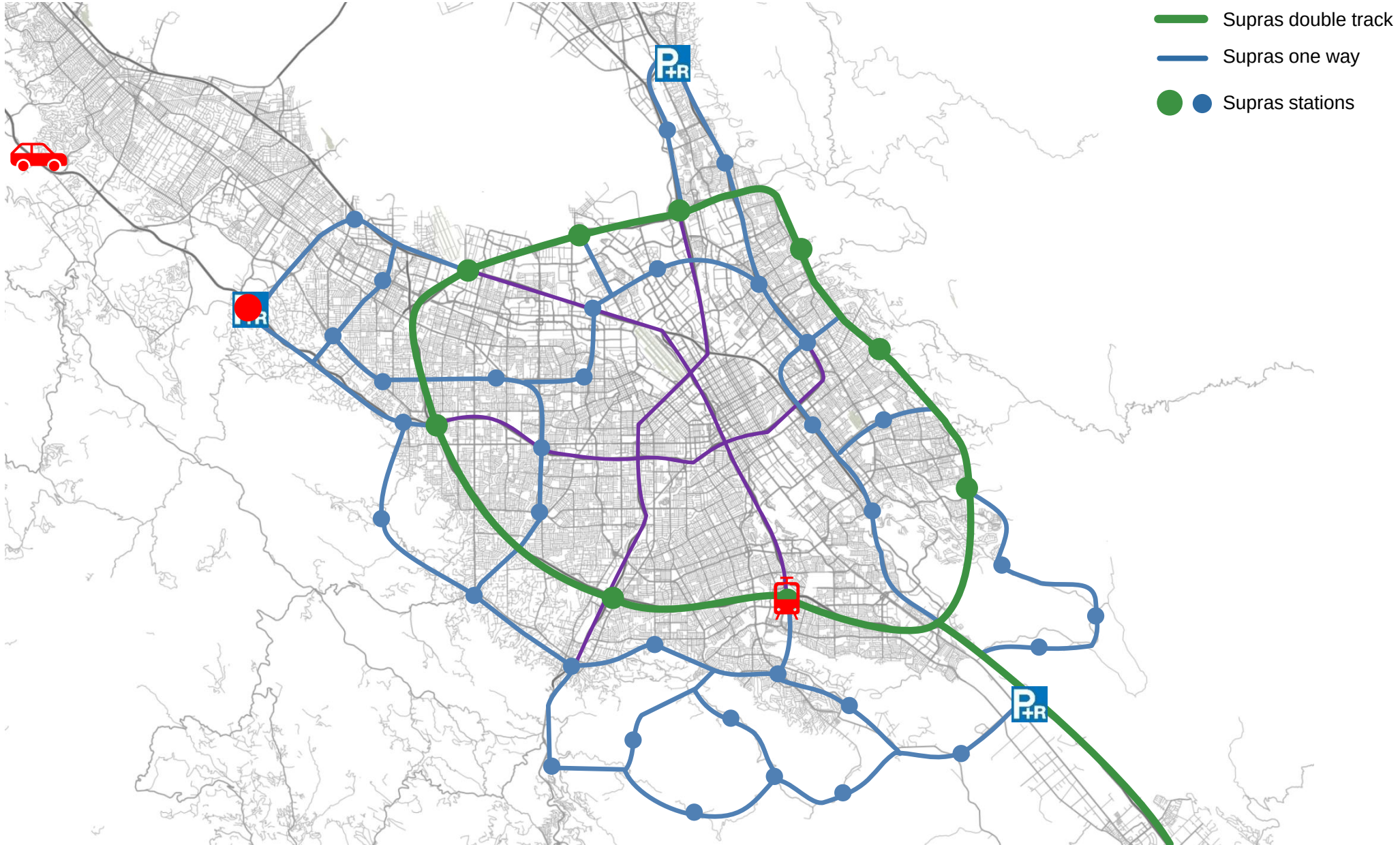
Current city situation all over the world



Supraways network implementation

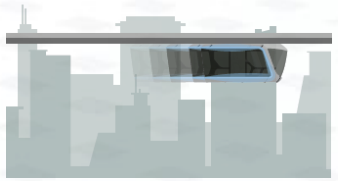


Supraways : the game changer for urban mobility

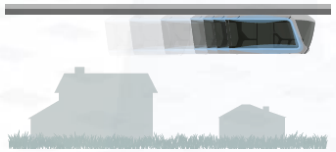


Main competitive advantages

SPEED & COMFORT



Urban
50 km/h
80 km/h in a straight line



Intercity
100 km/h
130 km/h in a straight line

HIGH CAPACITY SYSTEM

PASSENGERS PER HOUR AND PER DIRECTION

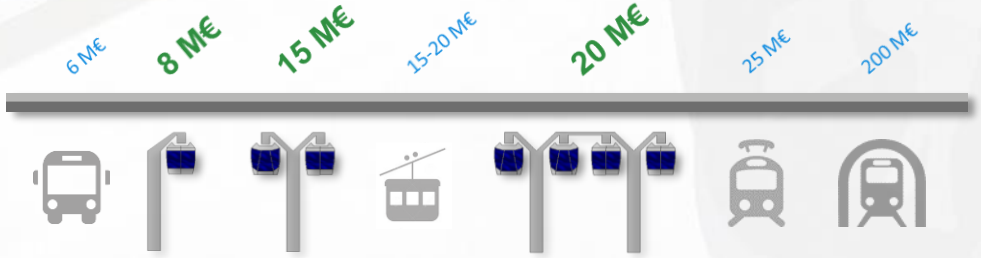
5 000 – 10 000

2 000
2 500
5 400
24 000

HIGHLY COMPETITIVE MODEL

TOTAL COST OF OWNERSHIP HIGHLY COMPETITIVE

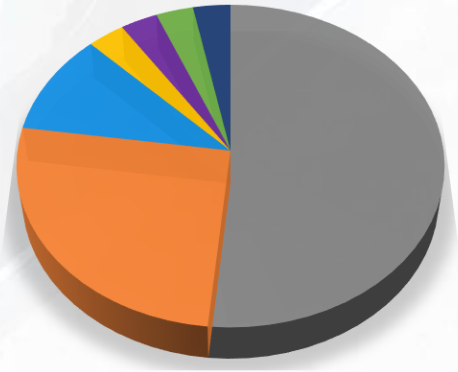
Investment cost M€ / km all-included:



Operation & maintenance cost< 50% classic TCU

No driver, speeds, efficiency and energy consumption

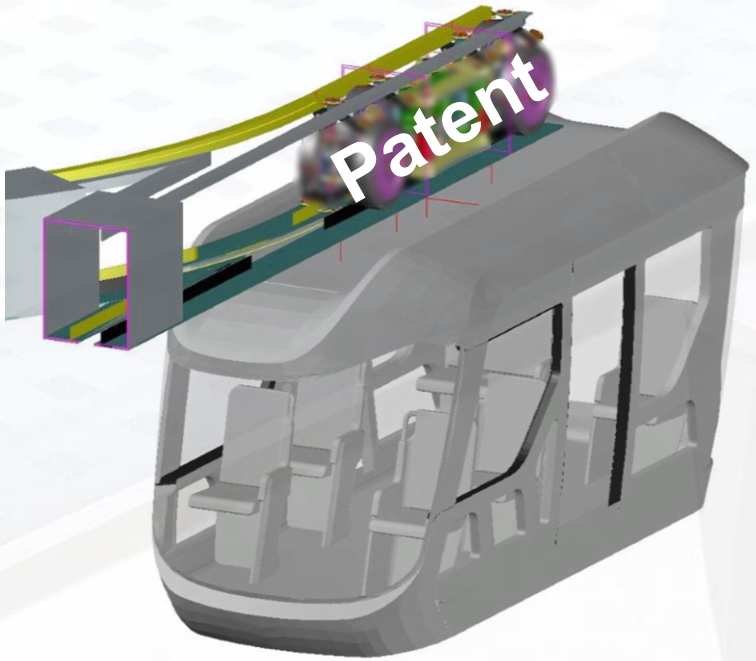
DIVERSIFIED REVENUE MODEL



- Passengers
- Logistic
- Rental of surfaces
- Waste
- Marketing
- Public services
- Other services

Major innovations

TECHNICAL INNOVATION
Auto-directive bogie

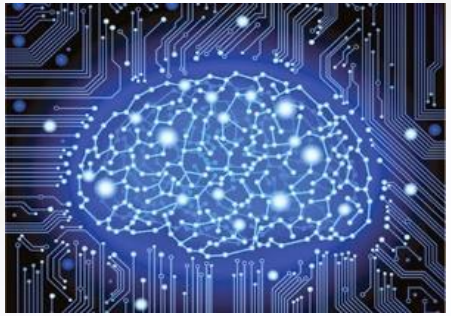


Electric propulsion

Embedded switching system

Suspension intelligence

TECHNICAL INNOVATION
Autonomous vehicles



Centralized control and communication system

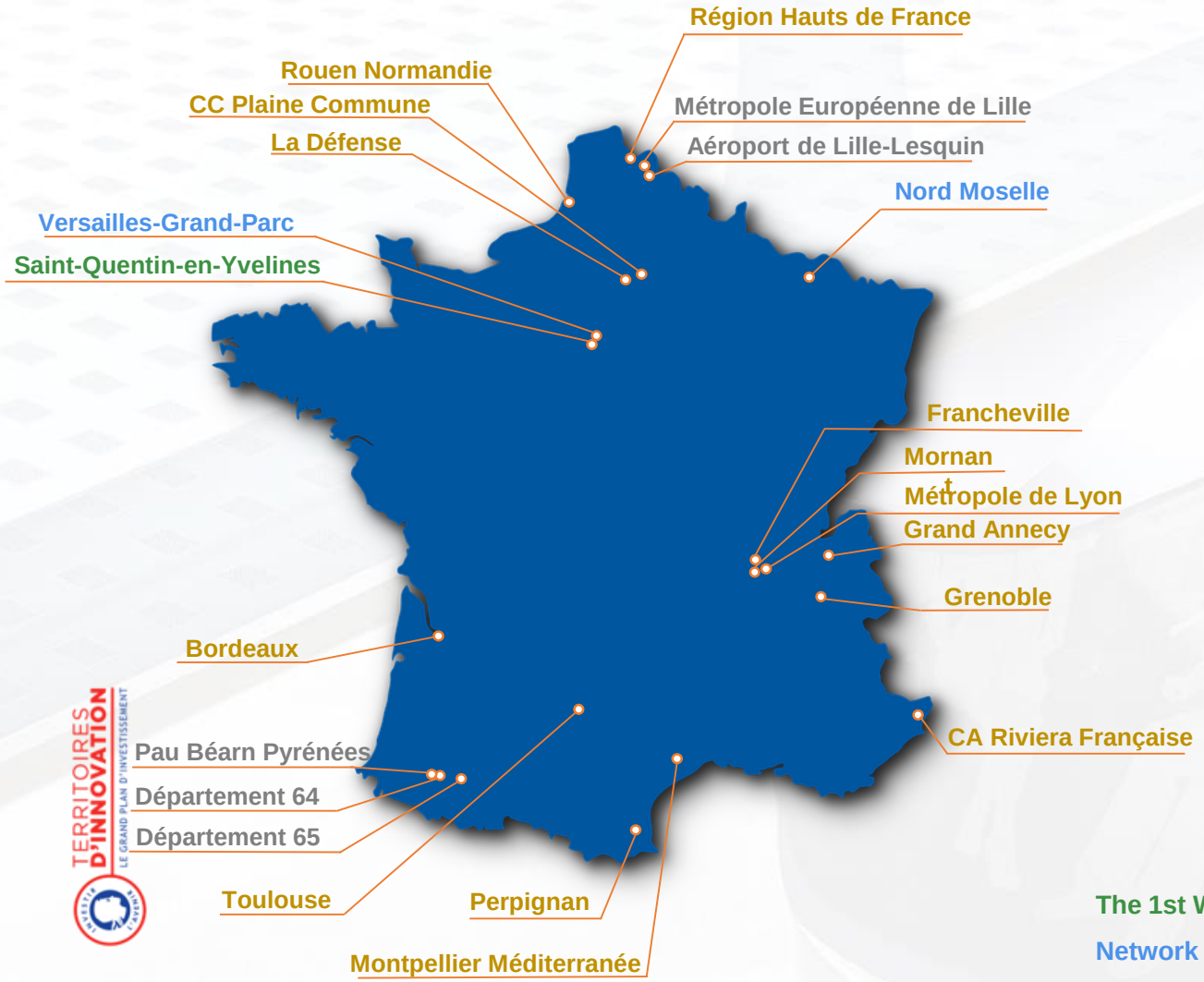
SOCIAL INNOVATION
Public MaaS

Comfortable, safe and on-demand public transit

URBAN INNOVATION
Re-design the city

Urban green corridors

Commercial pipeline : a growing interest for Supraways technology



La Réunion
TCO

La Suisse
Genève

Monaco

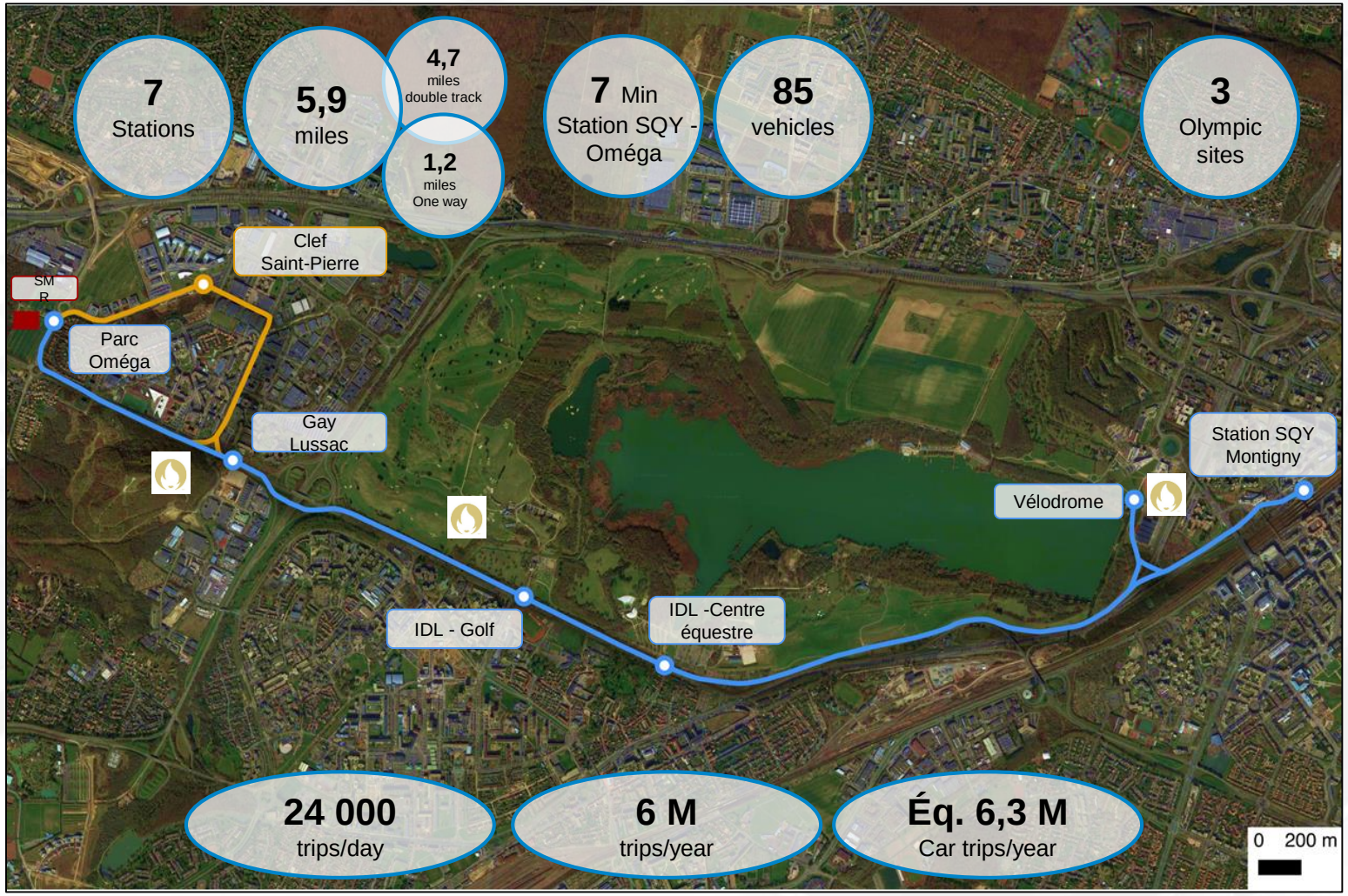
The 1st WW demonstrator JO 2024

Network studies phase

Start studies

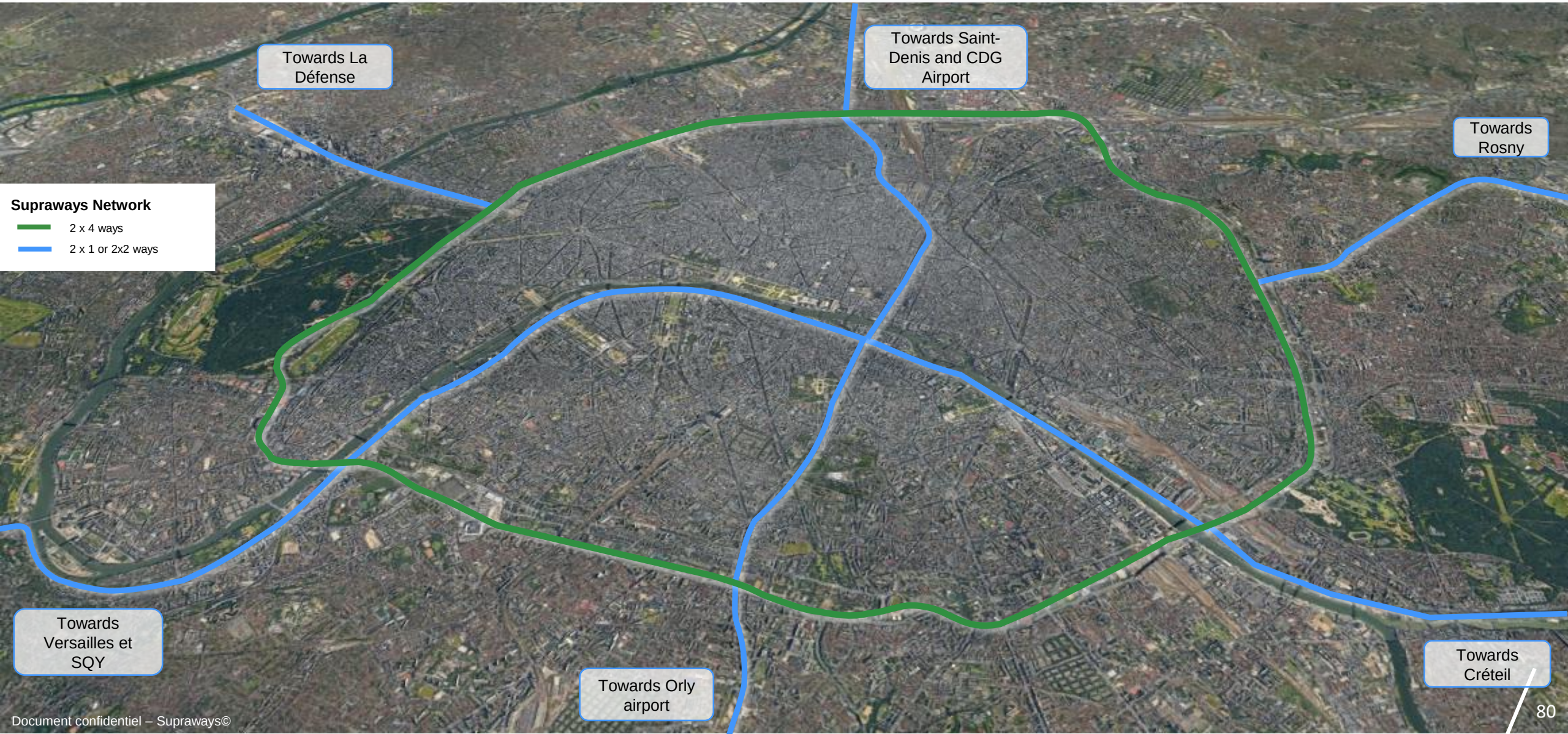
Submitted offers

Saint-Quentin-Yvelines, the first worldwide demonstrator

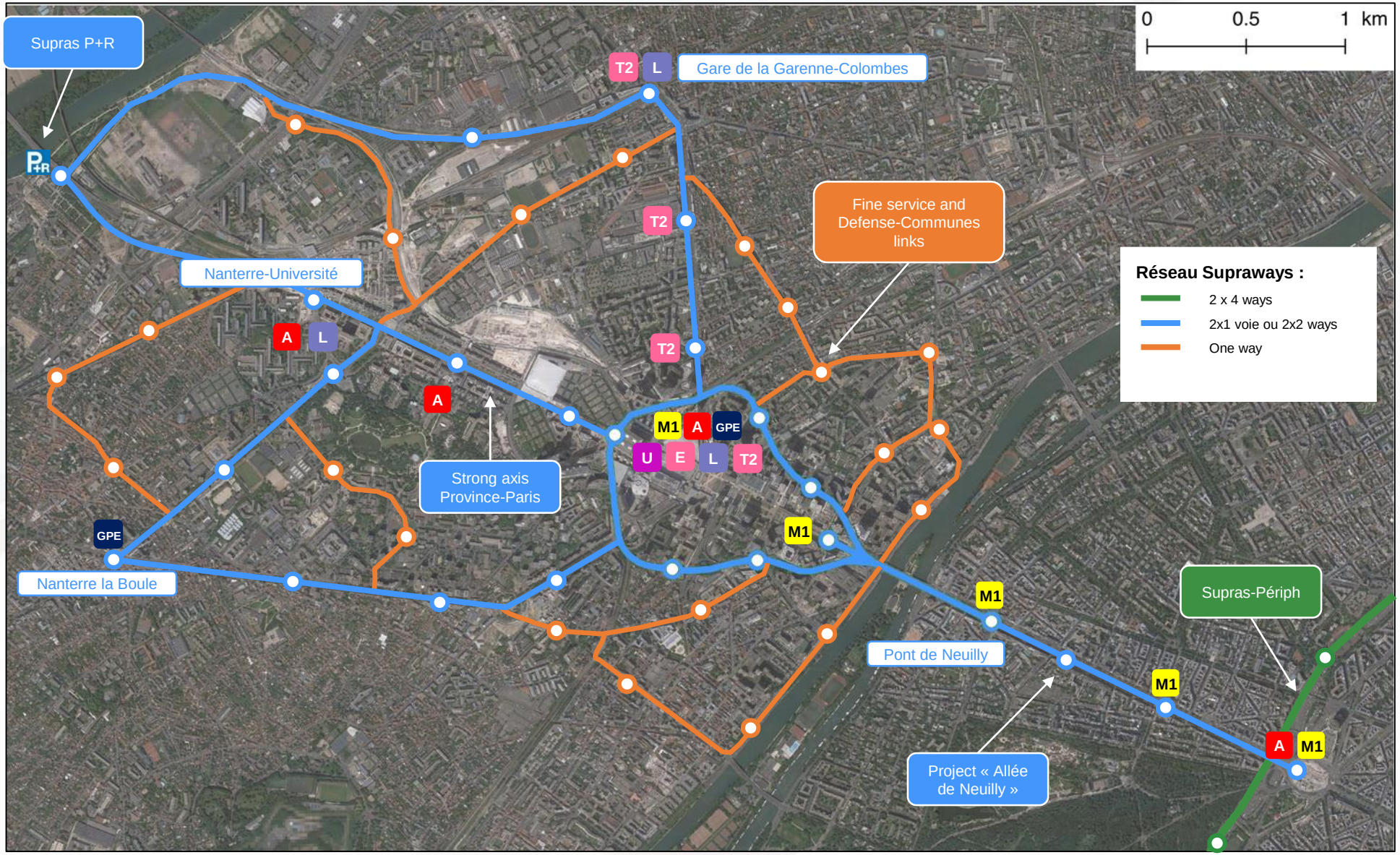


Ready for PARIS 2024

Paris in 2040 : Supraways backbone network



Paris in 2040 : example of extension around La Défense



Contact

Email : info@supraways.com

Tel : +33 632 722 616

Thanks for your attention

SUPRA WAYS
Fly in your city

Thank You