RESPIRA: Artificial intelligence for optimized management of ventilation and climatization systems in metro networks and railway stations

Enrique R. Gómez Cristóbal. SENER Ingeniería y Sistemas

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Who we are

A pioneer **engineering & technology** company for **65 years** | **Values**: innovation, quality and independence

417 M€ turnover | 2,400 employees | Permanent offices in 18 countries | Projects in more than 90 countries

Business units:

Infrastructures:

Railways

Urban transport

Roads

Airports

Ports

Water & environment

Architecture

Consultancy & New technologies

Major rail projects:

HSR Palmdale - Burbank USA)

Finch West LRT (Canada)

Toluca – Valle de Mexico Interurban Train (Mexico)

Edinburgh Tram. York Place - New Haven (Scotland)

HS2 Phase One London - Birmingham (UK)

Doha Metro. RLS, RLN, GL (Qatar)

Morogoro – Makutupora Railway Line (Tanzania)

Kaohsiung LRT (Taiwan)

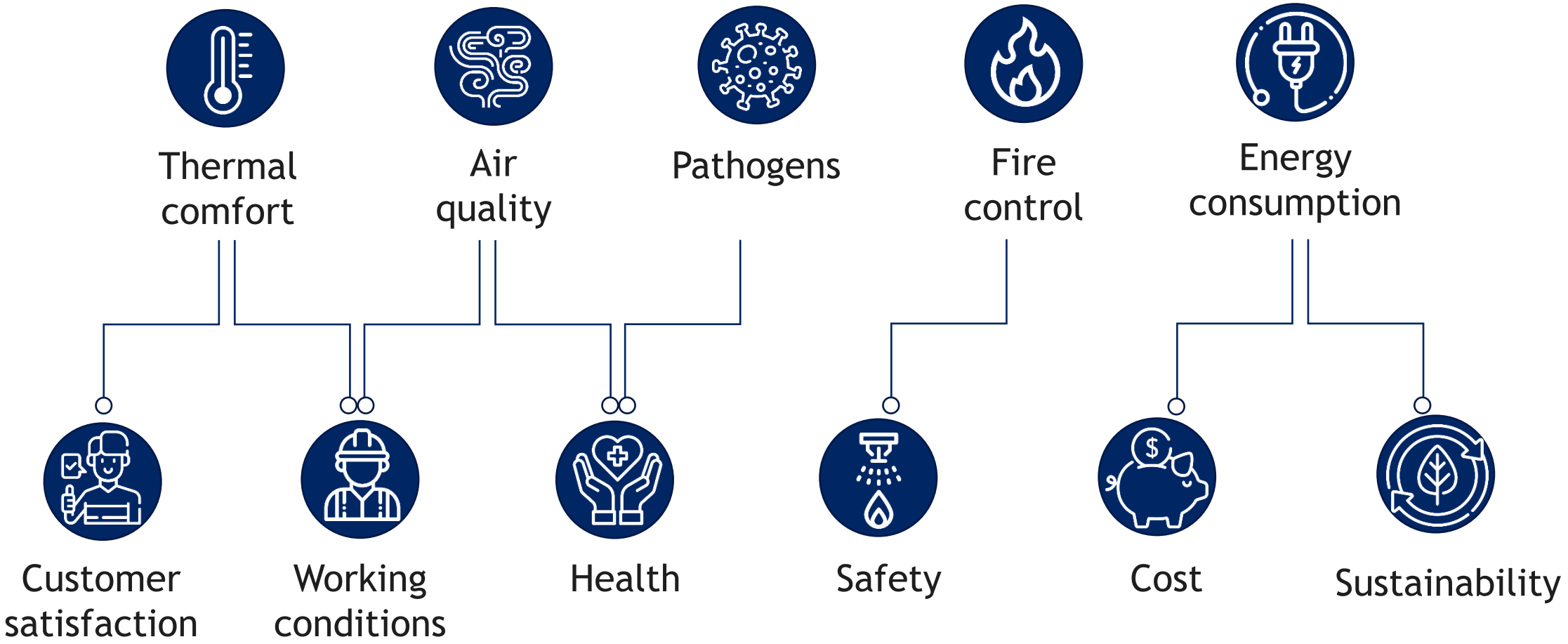
ENR Engineering News-Record

#65 International design firm

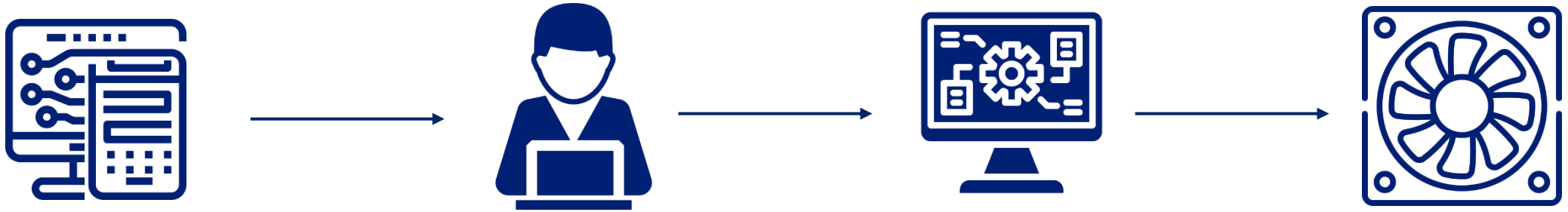
#15 Mass transit & rail design firm

Intelligent rail, intelligent ventilation

Importance of ventilation & climatization systems in stations



Traditional ventilation & climatization



Engineering studies
Calculations
Numerical models
Definition of strategies

Operator (HMI Level)
Configurable parameters:
Setpoints
Schedules
Mode tables

SCADA/BMS

Field equipment

- ✕ Simplified analysis of reality
- ✕ Limited number of scenarios analyzed
- ✕ Limitations of engineering calculations and numerical models
- ✕ Effort required for configuring parameters
- ✕ Non adaptive, changes require new studies

Evolution to intelligent ventilation: RESPIRA©

Real time data

Virtual automatic operator
Intelligent engineering
Machine learning

SCADA/BMS

Field equipment

(Configurable parameters)

Operator (HMI Level)
Mode configuration
Restrictions

- ✓ More accurate. Analysis based on real data
- ✓ Continuous retraining
- ✓ Permanently updated analysis. Best strategy at any given moment
- ✓ Adaptive, algorithms adapt to changes
- ✓ Identification of critical points in the system

The RESPIRA© formula

How it works

respira
now breathe

DATA	INDEXES	ALGORITHMS	OPERATION ORDERS

Environmental conditions:
- Temperature
- Humidity
- Pressure
- Air speed

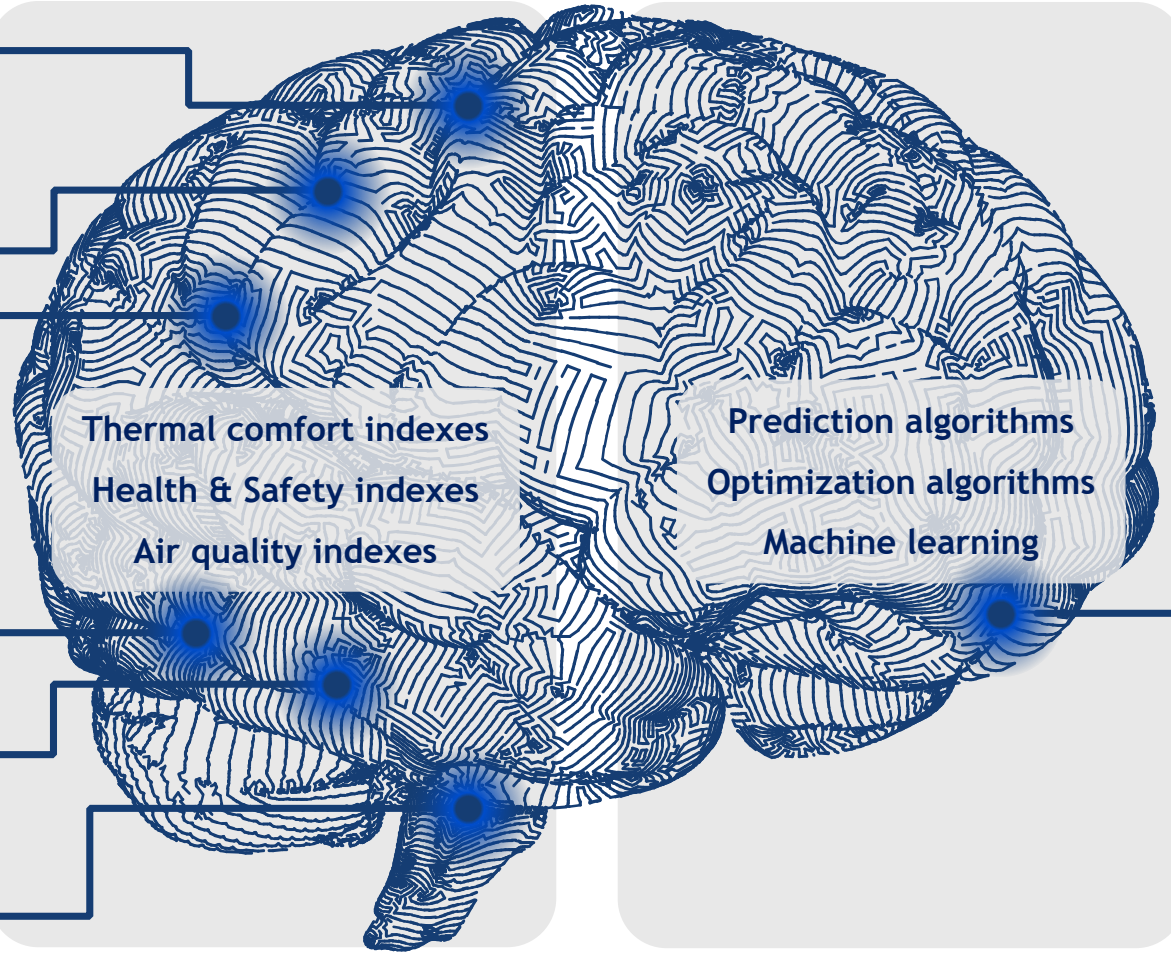
Air quality:
- Particulate matter (PM)
- CO_2
- NO_x

Weather forecast:
- Thermal conditions
- Rainfall
- Solar radiation

Operating parameters:
- Facility thermal loads
- Train frequency
- Platform occupancy

Mechanical parameters:
- Energy consumption
- Noise
- Vibrations

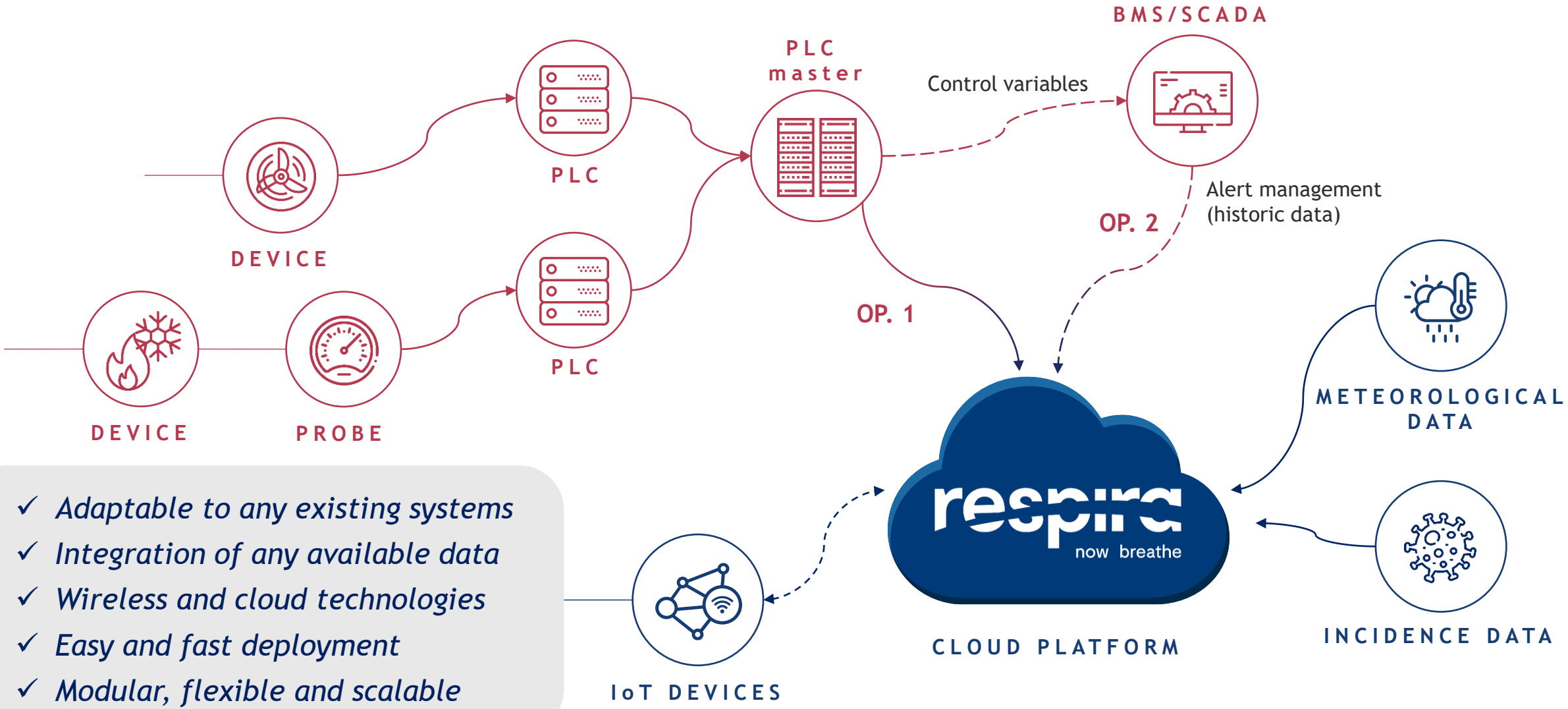
Operation modes



Operation orders every 1 h

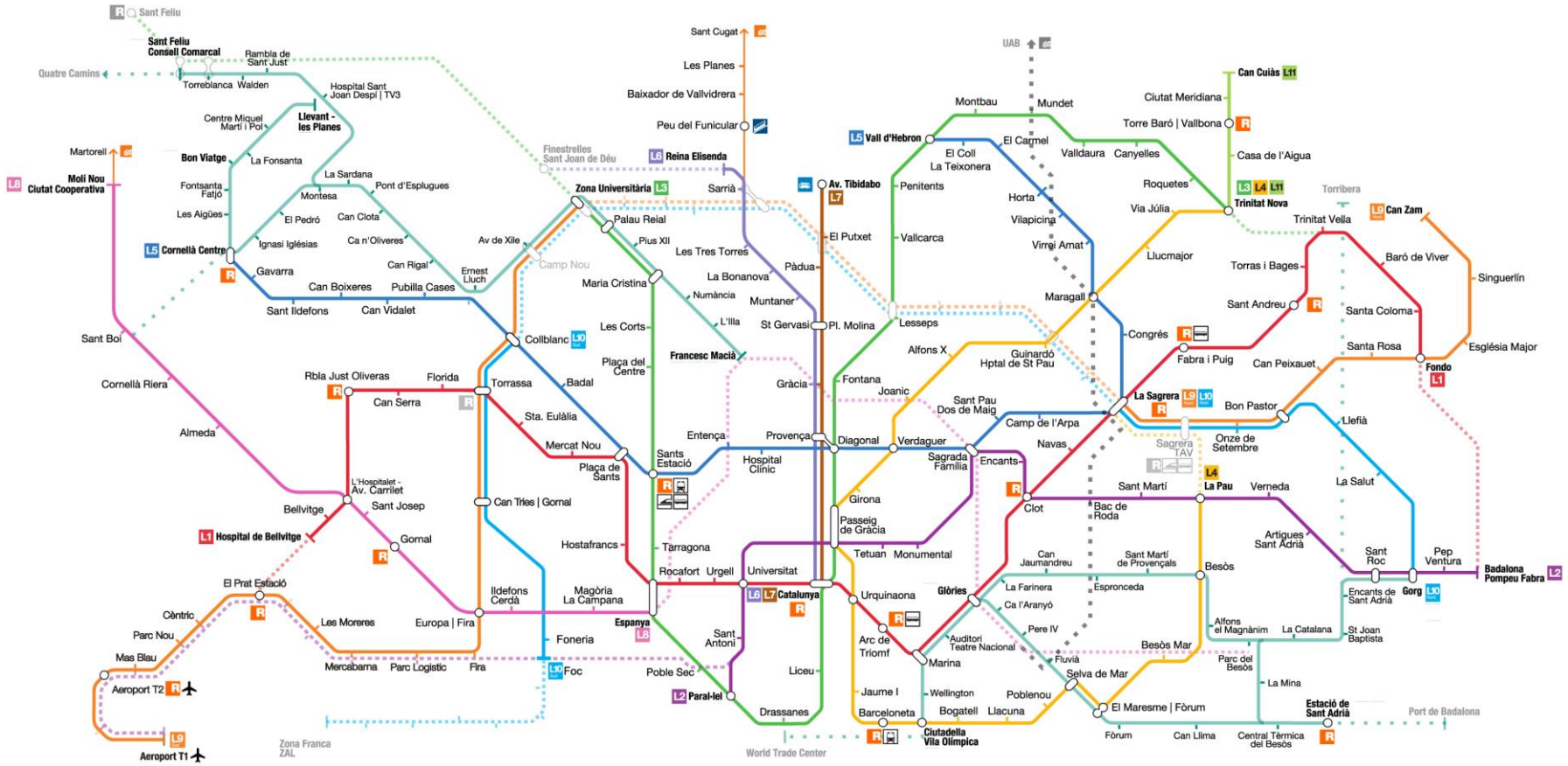
SENER

Architecture



- ✓ *Adaptable to any existing systems*
- ✓ *Integration of any available data*
- ✓ *Wireless and cloud technologies*
- ✓ *Easy and fast deployment*
- ✓ *Modular, flexible and scalable*

The case of Metro Barcelona



5 CONNECTED TRACKS

128 SUBWAY STATIONS

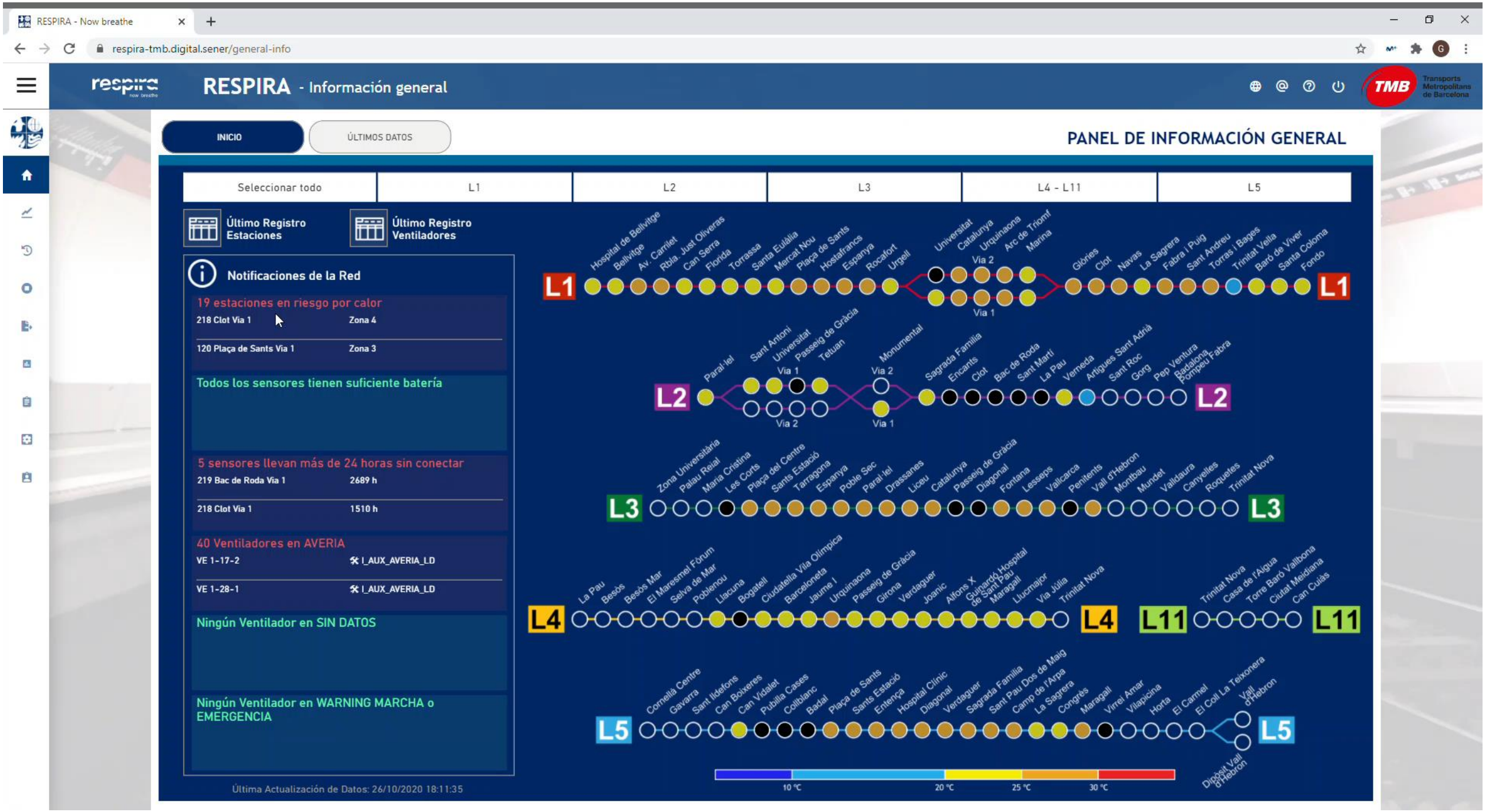
138 INDEPENDENT PLATFORMS

324 DISTRIBUTED VENTILATORS

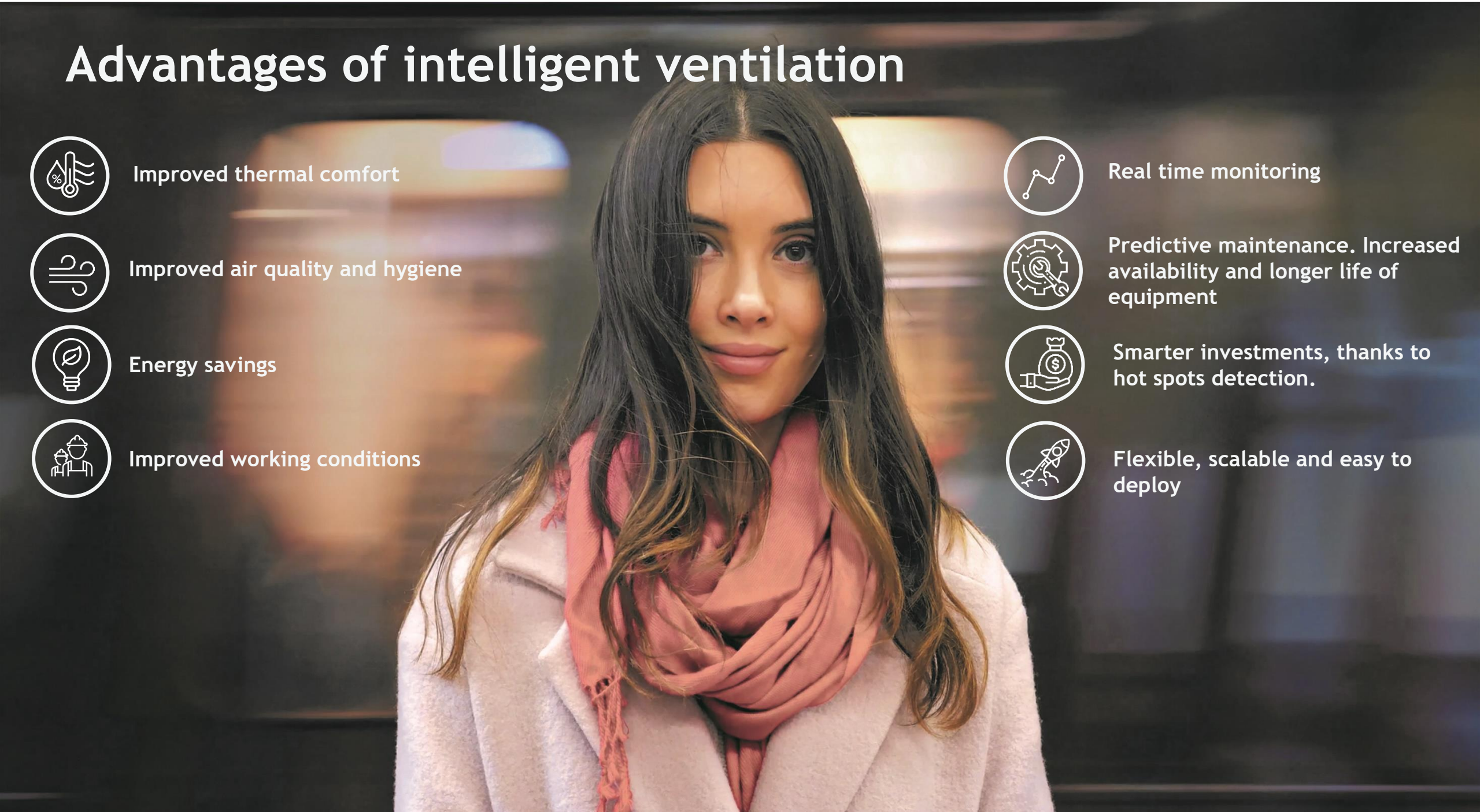
91 KM IN LENGTH

94% PASSAGES OF BARCELONA

>1M TRIPS PER DAY


RESPIRA - Now breathe
respira-tmb.digital.sener/general-info
respira
RESPIRA - Información general
TMB
Transports Metropolitans de Barcelona
INICIO
ÚLTIMOS DATOS
PANEL DE INFORMACIÓN GENERAL
Seleccionar todo
L1
L2
L3
L4 - L11
L5
Último Registro Estaciones
Último Registro Ventiladores
Notificaciones de la Red
19 estaciones en riesgo por calor
218 Clot Via 1 Zona 4
120 Plaça de Sants Via 1 Zona 3
Todos los sensores tienen suficiente batería
5 sensores llevan más de 24 horas sin conectar
219 Bac de Roda Via 1 2689 h
218 Clot Via 1 1510 h
40 Ventiladores en AVERIA
VE 1-17-2 I_AUX_AVERIA_LD
VE 1-28-1 I_AUX_AVERIA_LD
Ningún Ventilador en SIN DATOS
Ningún Ventilador en WARNING MARCHA o EMERGENCIA
Última Actualización de Datos: 26/10/2020 18:11:35
10 ºC
20 ºC
25 ºC
30 ºC

Advantages of intelligent ventilation



- Improved thermal comfort
- Improved air quality and hygiene
- Energy savings
- Improved working conditions
- Real time monitoring
- Predictive maintenance. Increased availability and longer life of equipment
- Smarter investments, thanks to hot spots detection.
- Flexible, scalable and easy to deploy

Metro Barcelona results

1.3ºC

Average temperature drop inside the stations

10.7%

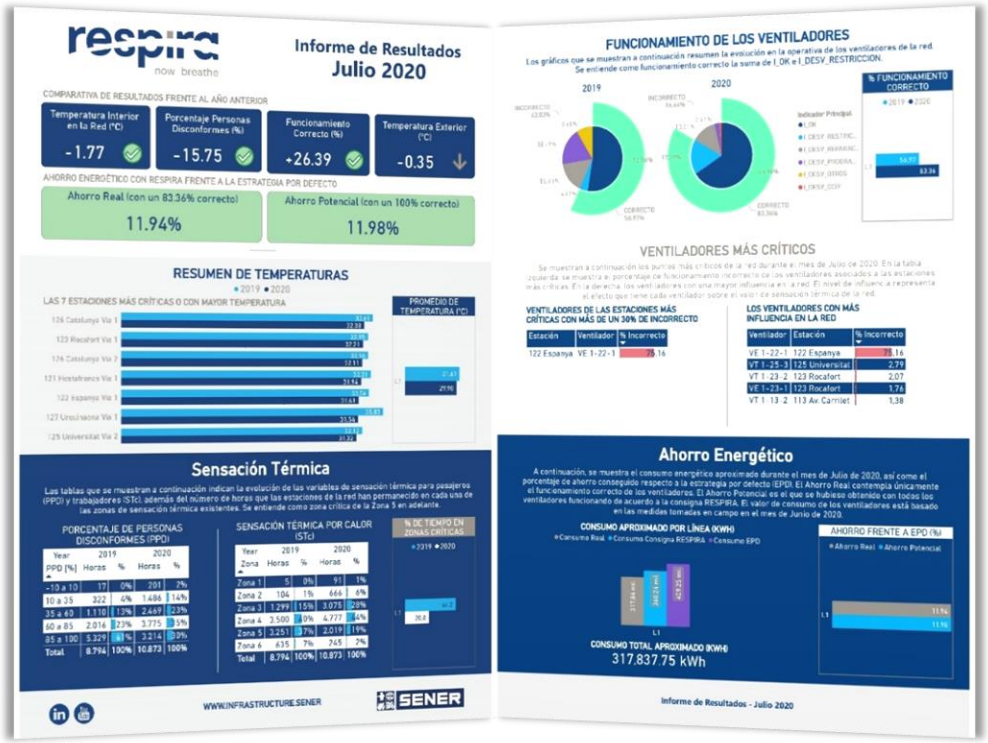
Increase in users' satisfaction as to the atmosphere conditions
(based on the comfort index)

20.9%

Increase in fan performance

11.8%*

Average energy savings
*Year-on-year comparison (2019-2020) in central stations of Line 1, the first one to implement RESPIRA. Data collected from July to October in pandemic
Estimation of annual energy savings in normal situation: 20-25%

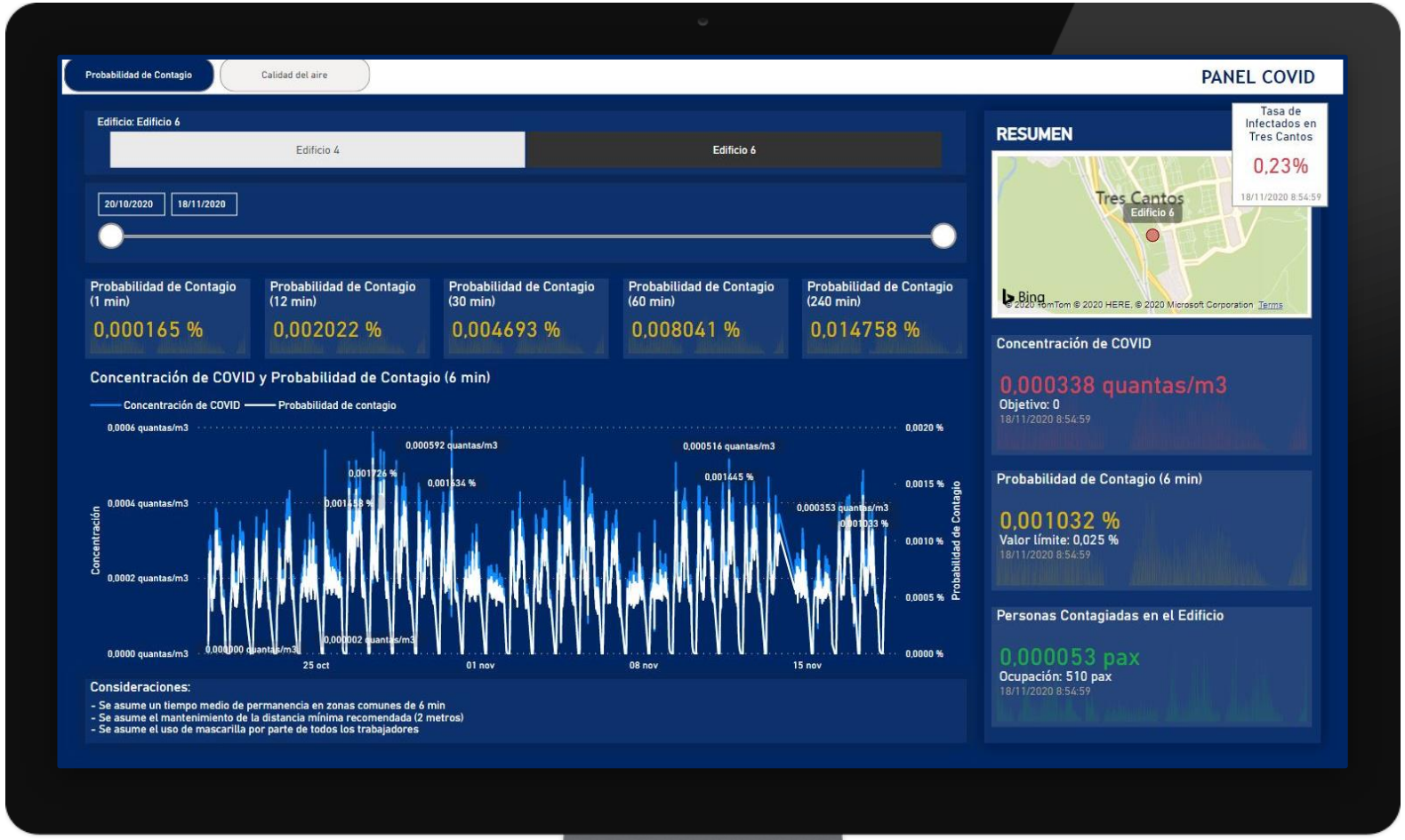


Monthly report of results

Sanitary and phytosanitary capacities

COVID-19 Aerosol Transmission Estimator Probability of Contagion Risk

Based in the methodology developed by Professor Jose Luis Jimenez (University of Colorado Boulder)



From ventilation to climatization

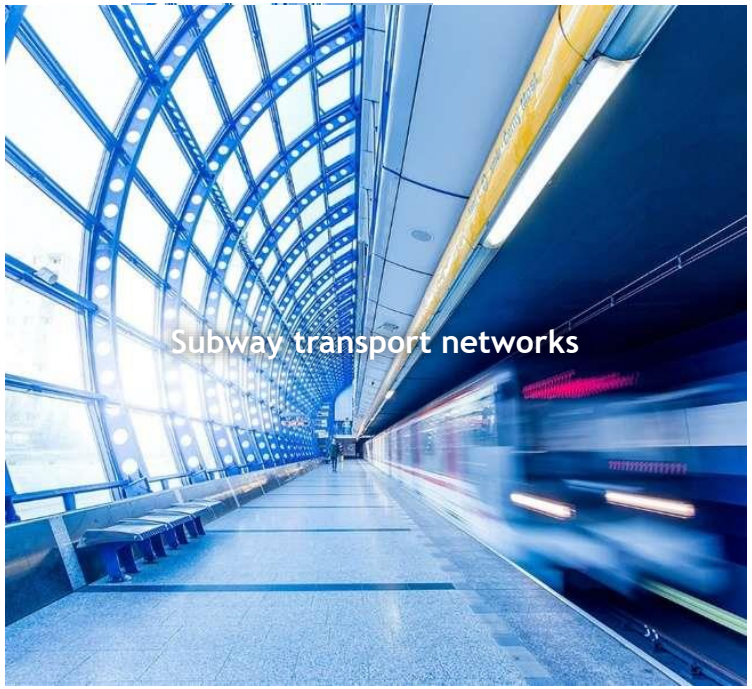
The case of SENER offices in Tres Cantos (Madrid)

- **7** — **BUILDINGS** CONNECTED
- **3** — **FLOORS** PER BUILDING
- **1** — **CENTRAL ATRIUM** PER BUILDING
- **1** — **HEATING/COOLING** PLANT
- **7** — **AIR HANDLING** UNITS
- **84** — **VAV UNITS** VARIABLE AIR VOLUME UNITS
- **42** — **CAV** CONSTANT AIR VOLUME UNITS

Potential applications for intelligent ventilation & climatization

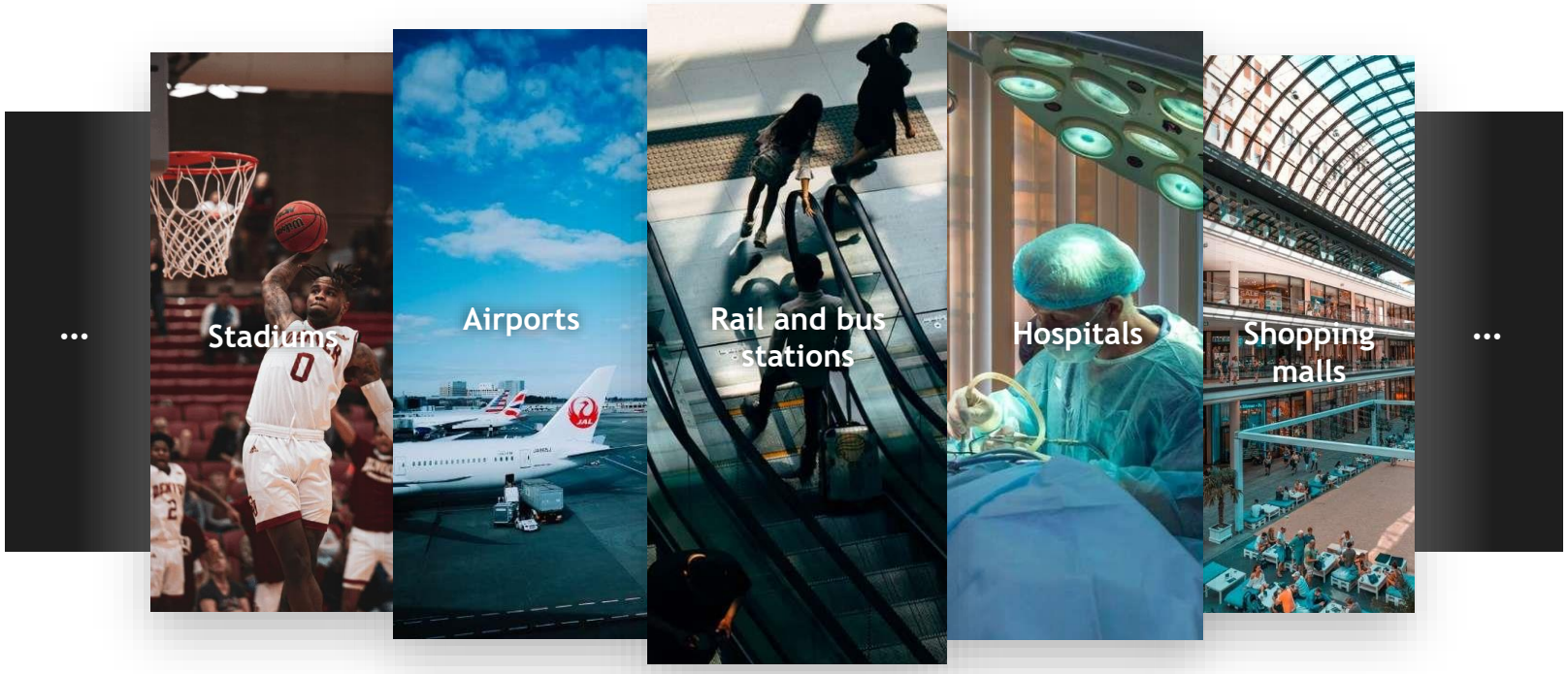
Suburban transport

Ventilation system



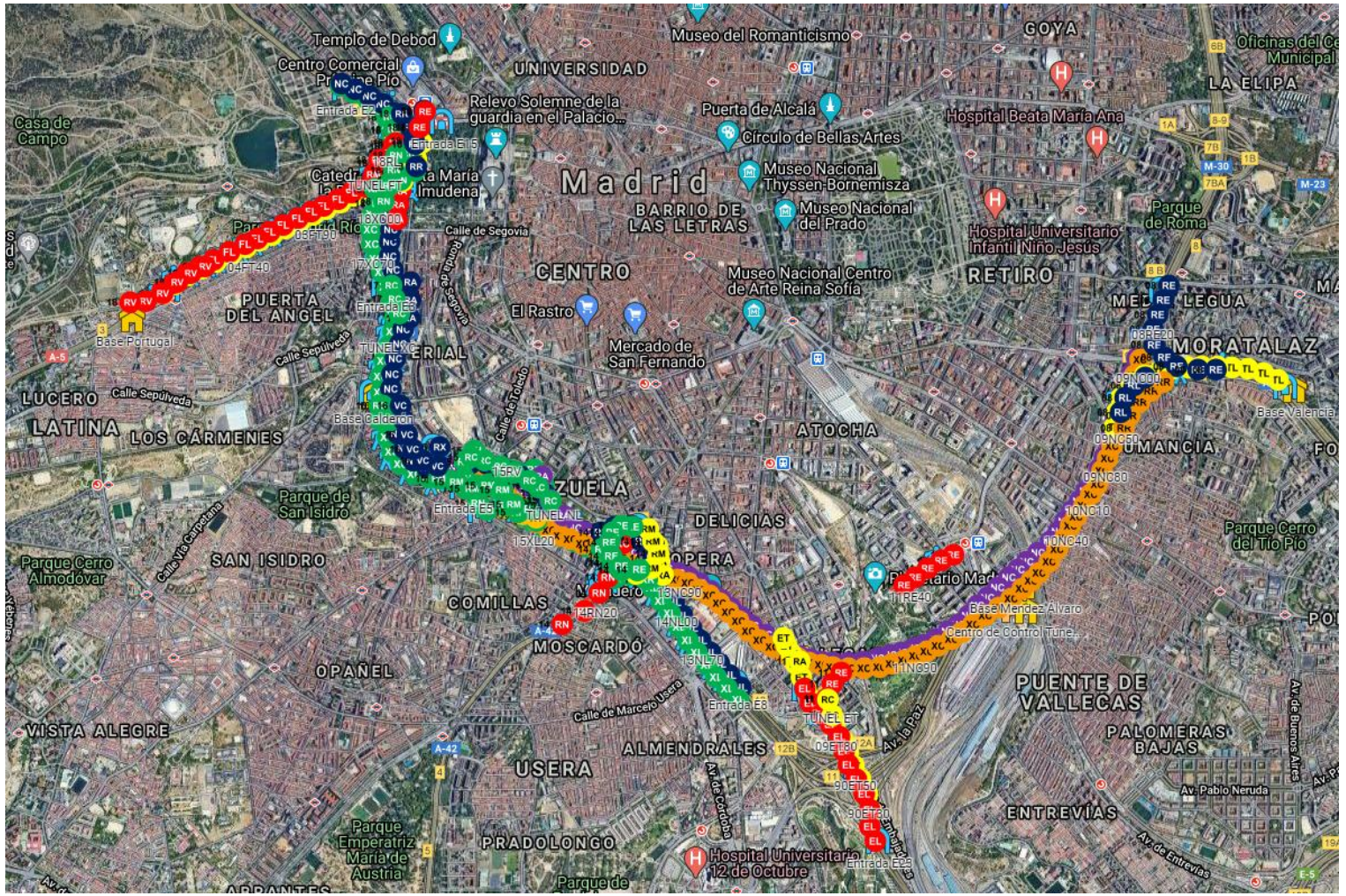
Large scale infrastructures and connected spaces

HVAC



RESPIRA© for definition of fire algorithms

The case of Madrid M-30 road tunnels



30 **Miles** IN LENGTH

11 **MAIN TUNNELS** CONNECTED

21 **INDEPENDENT** ENTRANCES

22 **INDEPENDENT** EXITS

1000 **DISTRIBUTED** VENTILATORS

>2M **TRIPS** PER DAY

Want to know more?

www.infrastructure.sener | www.en.respira.sener

enrique.gomez@sener.es

www.linkedin.com/in/enriquegomezcristobal

THANK YOU VERY MUCH
MUCHAS GRACIAS
ESKERRIK ASKO