Increasing Resilience

Decision Support Systems for the Management and Increasing Resilience of REN's Gas and Electricity Infrastructure Facing the Risk of Forest Wildfire

Authors:

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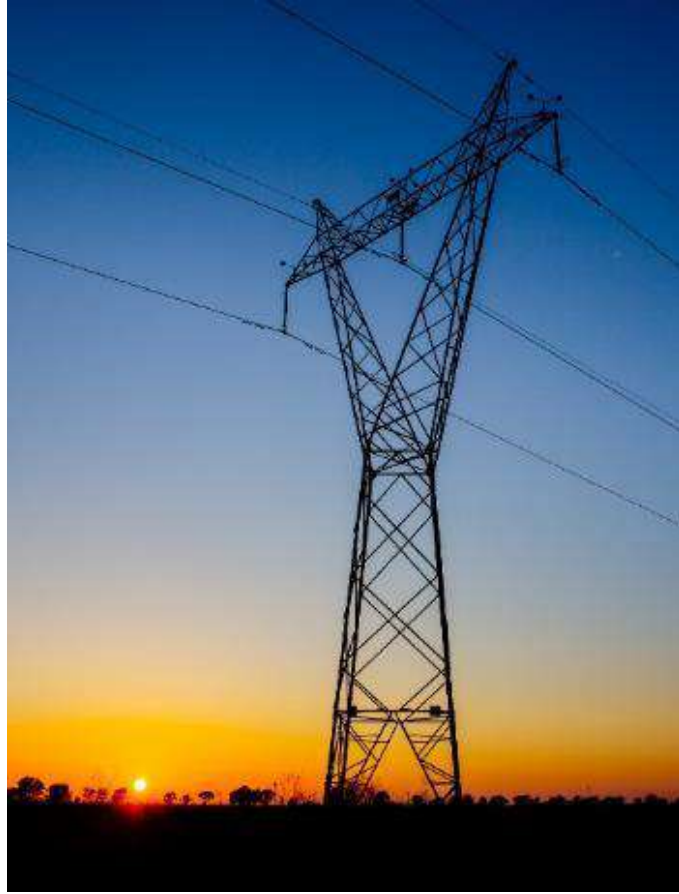Rui Roda, whereness
Carlos Viegas, University of Coimbra

Integrated Transmission System Operator

Energy Transmission networks in Portugal

ELECTRICITY- TRANSMISSION LINES
Length of Lines: more than 9300km

NATURAL GAS PIPELINES
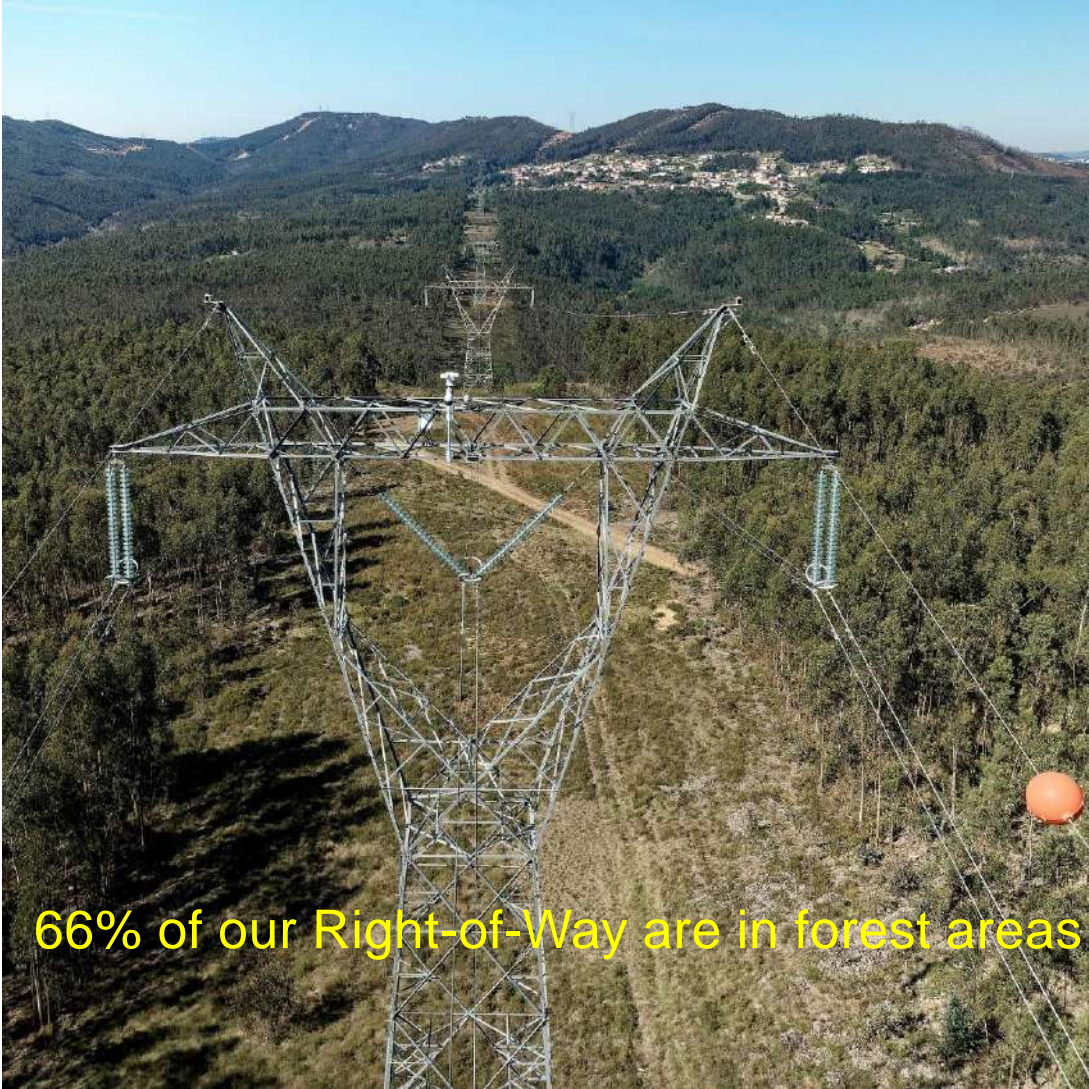Pipeline Length: almost 1400km

More than 35000ha of Right-of-Way

Wildfires impact on REN infrastructures

Why use existing REN infrastructure for forest monitoring?
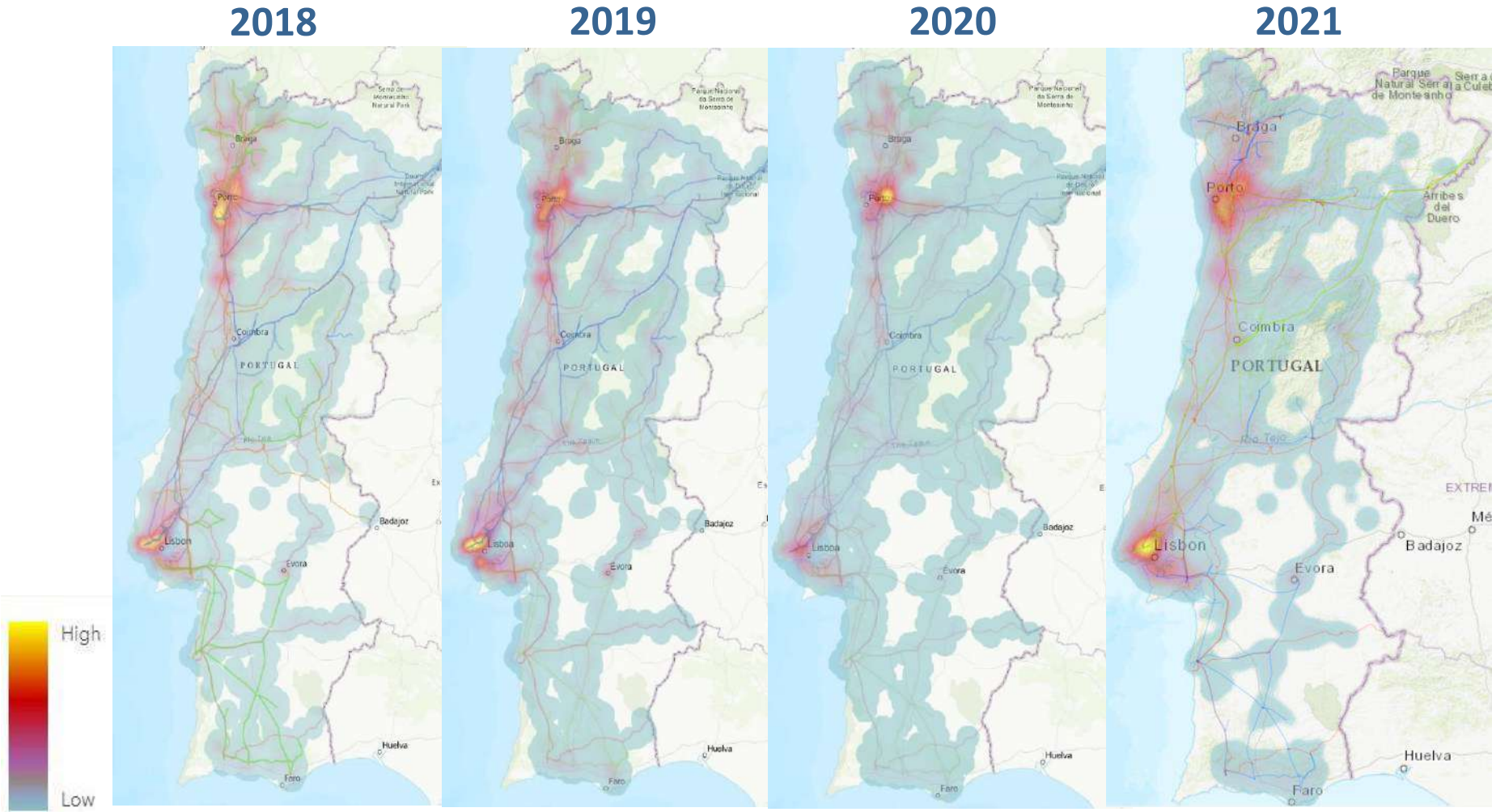

66% of our Right-of-Way are in forest areas

REN and the forest wildfires

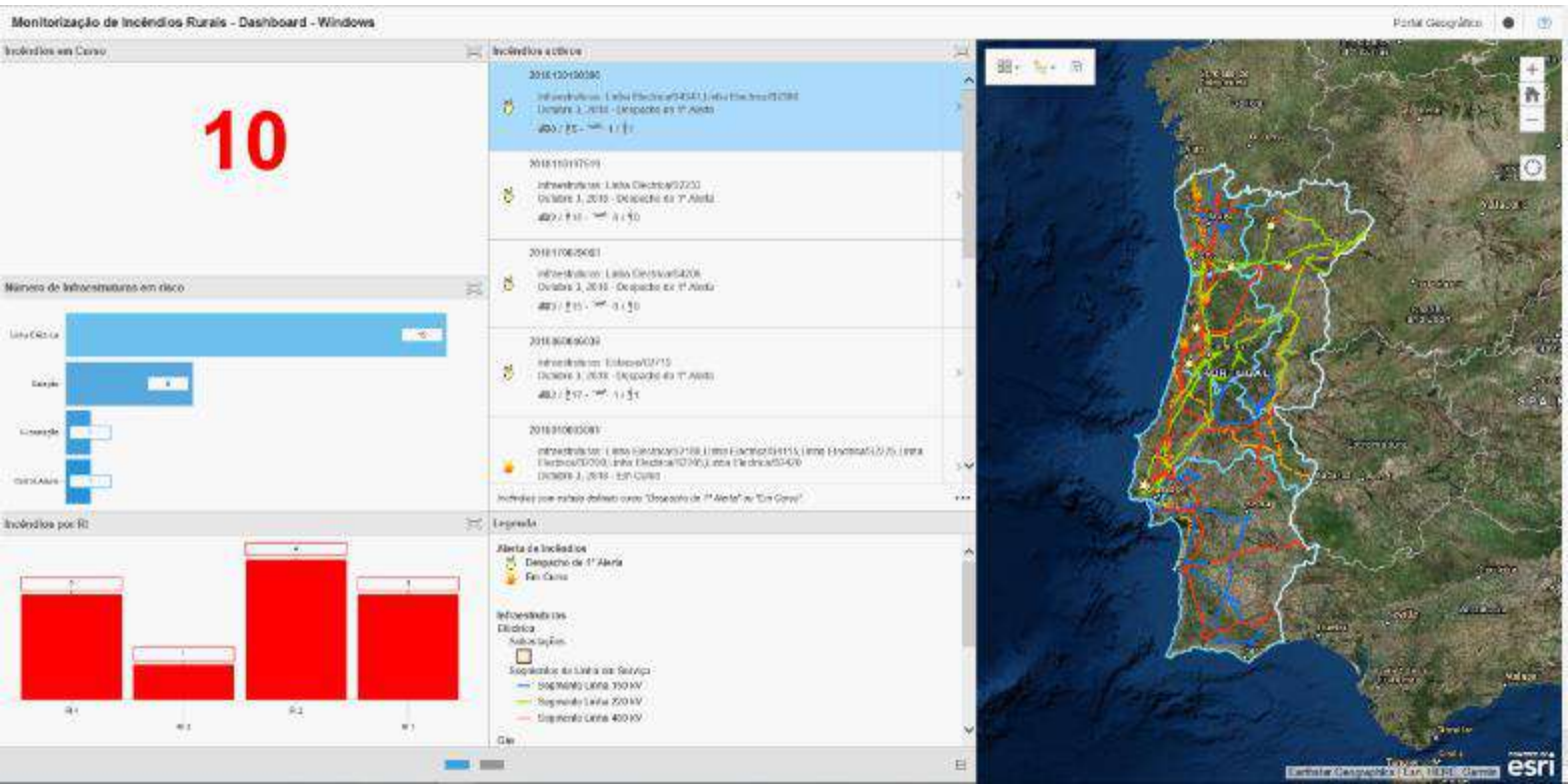**Heatmap of rural fire occurrences inside a 5 km buffer of REN infrastructures**

2018   **2019**   **2020**   **2021**

High

Low

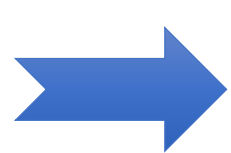**Average of 5000 occurrences each year.**

In one day (13 July 2022) we had more than 195 occurrences near REN infrastructures!

REN and the forest wildfires

Forest Fire Alert System – Develop in 2017 with ESRI tools

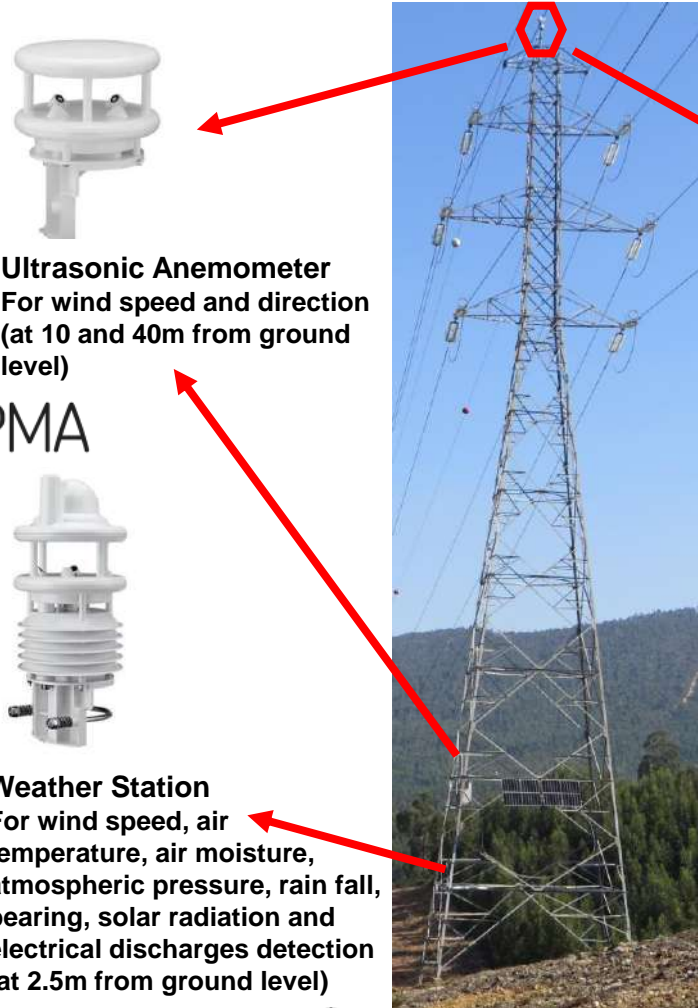**Forest wildfires dashboard**
< 5 km critical infrastructures

Incoming SMS (text message) when at less than 2km

Innovative ways: Infrastructures Monitoring
Hardware and demonstration zones

As part of this project, REN is installing **eight (8) infrastructure monitoring systems**...

Ultrasonic Anemometer
For wind speed and direction (at 10 and 40m from ground level)

Weather Station
For wind speed, air temperature, air moisture, atmospheric pressure, rain fall, bearing, solar radiation and electrical discharges detection (at 2.5m from ground level)

Main Camera
Ignitions and smoke columns detection based on IR and visible cameras

Secondary Camera
Tracking events based on visible camera

Demonstration zones

... in three demonstration zones, which represent three different types of territories, but all subject to the pressure of rural wildfires.

Innovative ways: Infrastructures Monitoring
Main Camera - Fire detection AI and Timelapse

Innovative ways: Infrastructures Monitoring
Secondary Camera - Real-time data

Solution: Decision Support System
GIS (frontend) and Fire Propagation Simulator (isochronous lines)

Infrastructures Monitoring and Decision Support System

Increased security in other infrastructures such as energy, roads, rails, and industrial areas

Infrastructures Monitoring and Decision Support System

Increasing resilience of REN's Infrastructure

- No longer **focus** on the wildfire ignition point, but on the **time and place** where it will likely **impact** the gas and electricity transmission network.

- Knowing which forest wildfires can really impact our network we can have a **reduction of alerts**.

- Is possible to monitor forest wildfires that start **outside the 5 km buffer** and from there, **make new simulations**.

- **Have a better efficiency** in activating prevention and surveillance teams and other support staff, in dispatch and operation rooms.

- **Providing services to other entities, helping companies and communities.**

Infrastructures Monitoring
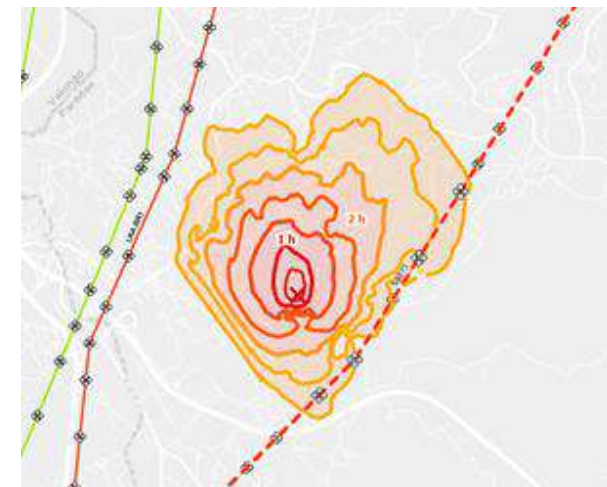
Decision Support System

A Decision Support System
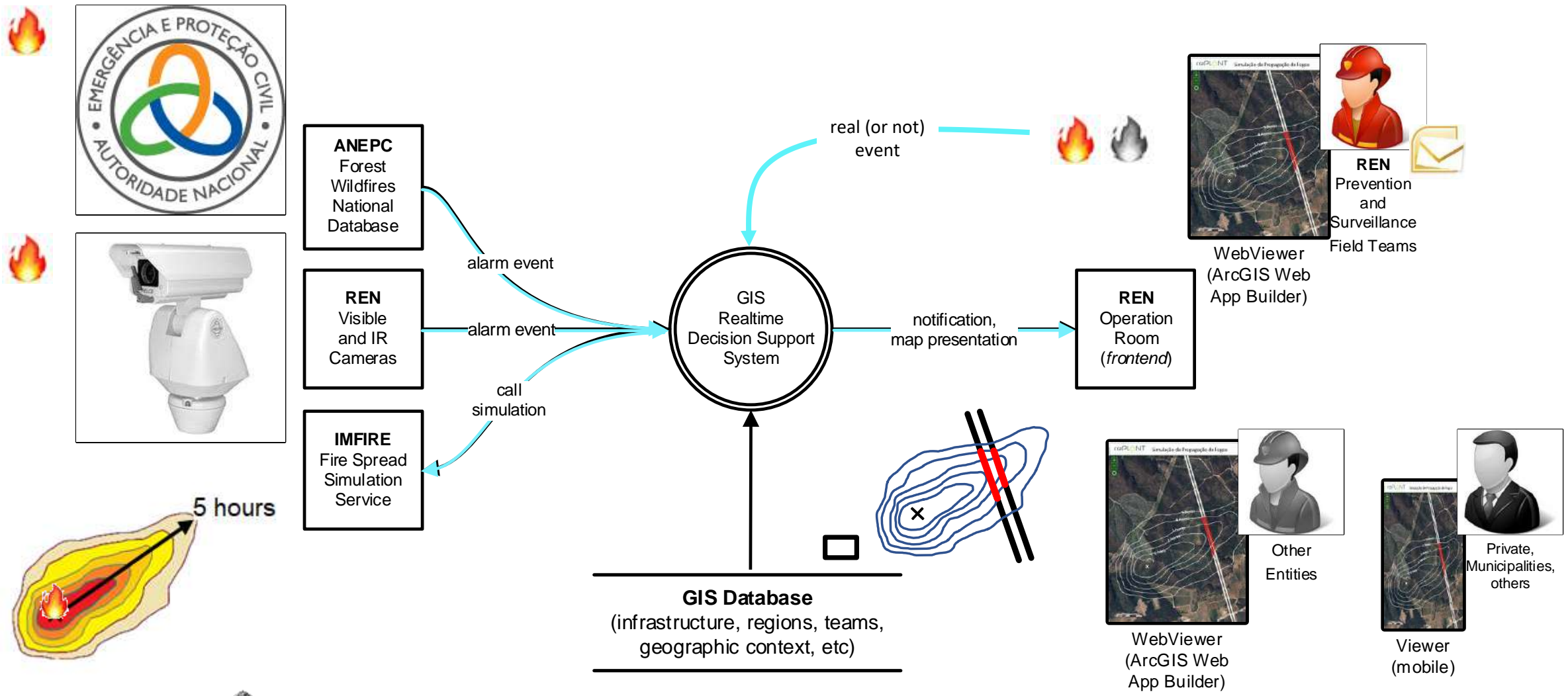## Solution Use Workflow

ANEPC Forest Wildfires National Database

REN Visible and IR Cameras

IMFIRE Fire Spread Simulation Service

alarm event

alarm event

call simulation

5 hours

GIS Realtime Decision Support System

real (or not) event

notification, map presentation

REN Operation Room (*frontend*)

GIS Database (infrastructure, regions, teams, geographic context, etc)

WebViewer (ArcGIS Web App Builder)

REN Prevention and Surveillance Field Teams

WebViewer (ArcGIS Web App Builder)

Other Entities

Viewer (mobile)

Private, Municipalities, others

A Decision Support System
GIS frontend

Fire Propagation Simulation

Based on advanced Wildfire, Smoke and Weather models, coupled with AI.

- ✓ Simulation of the fire spread and behavior, coupled with atmospheric changes, for a local set of parameters, including topography, vegetation (fuel) and weather.
- ✓ Available as stand-alone web-based platform or API.
- ✓ Simulation time below 2 minutes, for predictions up to 5 hours in the future.

IMFIRE
INTELLIGENT MANAGEMENT FOR WILDFIRES
Project Ref. PCIF/SSI/0151/2018

https://adai.pt/imfire/

Simulation Process – Overview

Input data

From user:
- Fire ignition (time and coordinates)
- Local wind speed and direction (optional)

From database:
- Terrain (slope/aspect/DEM)
- Fuel Models and Maps (fuel load, depth, physical and chemical properties, …)

Automatic data fetching from online sources:
- Fuel moisture content
- Local wind speed and direction

Models

Fire 1 - Rothermel (1972) surface fire spread model

Fire 2 - Van Wagner (1977) and Cruz, Alexander, Wakimoto (2005) crown fire models.

Fire 3 – Albini (1979) spot fire model

Wind 1 - Nuatmos Kinematic model; smooth topography; no thermal effects; numerically stable and low computational times;

Wind 2 - Canyon Full 3D Navier-Stokes solver; complex topography; thermal and turbulence effects; terrain roughness or vegetation effects modelled; long computational times

Smoke 1 - Disperfire (2007) 3D Smoke concentration model

FMC 1 – Lopes (2014) Equilibrium moisture content and timelag model

Results

- Fire rate of spread
- Fire line intensity
- Flame height
- Wind map
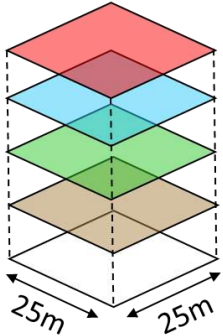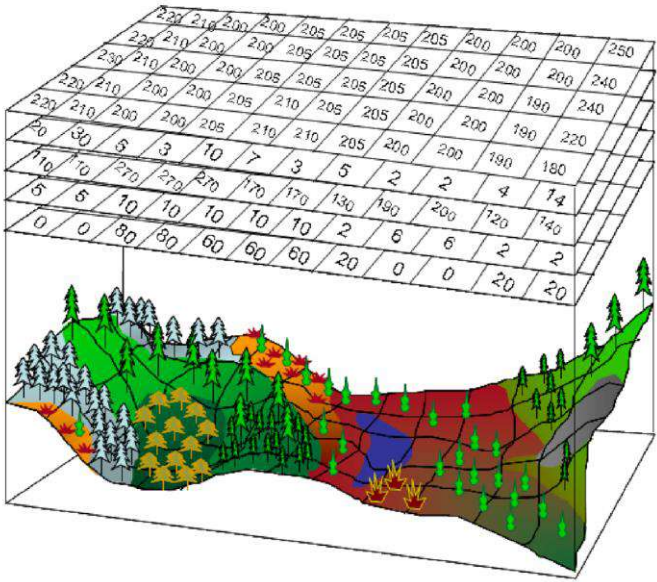- Smoke generation
- Smoke dispersion and concentration

GA Algorithms

Simulation Process – Input data

**Worldwide** coverage capable

Maps:
1. Ignitions – burning cells
2. Wind – wind speed U (x and y direction)
3. Fuels – fuel model
4. Slope – slope Φ
5. Coordinates – scale

Simulation Process – Fire Behaviour Models

Surface Fire   Crown Fire   Spotting Fire

Fire whirl   Eruptive Fire   Merging Fire

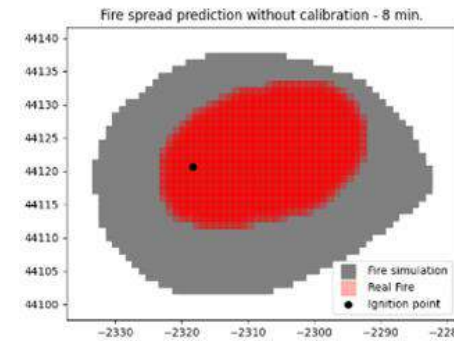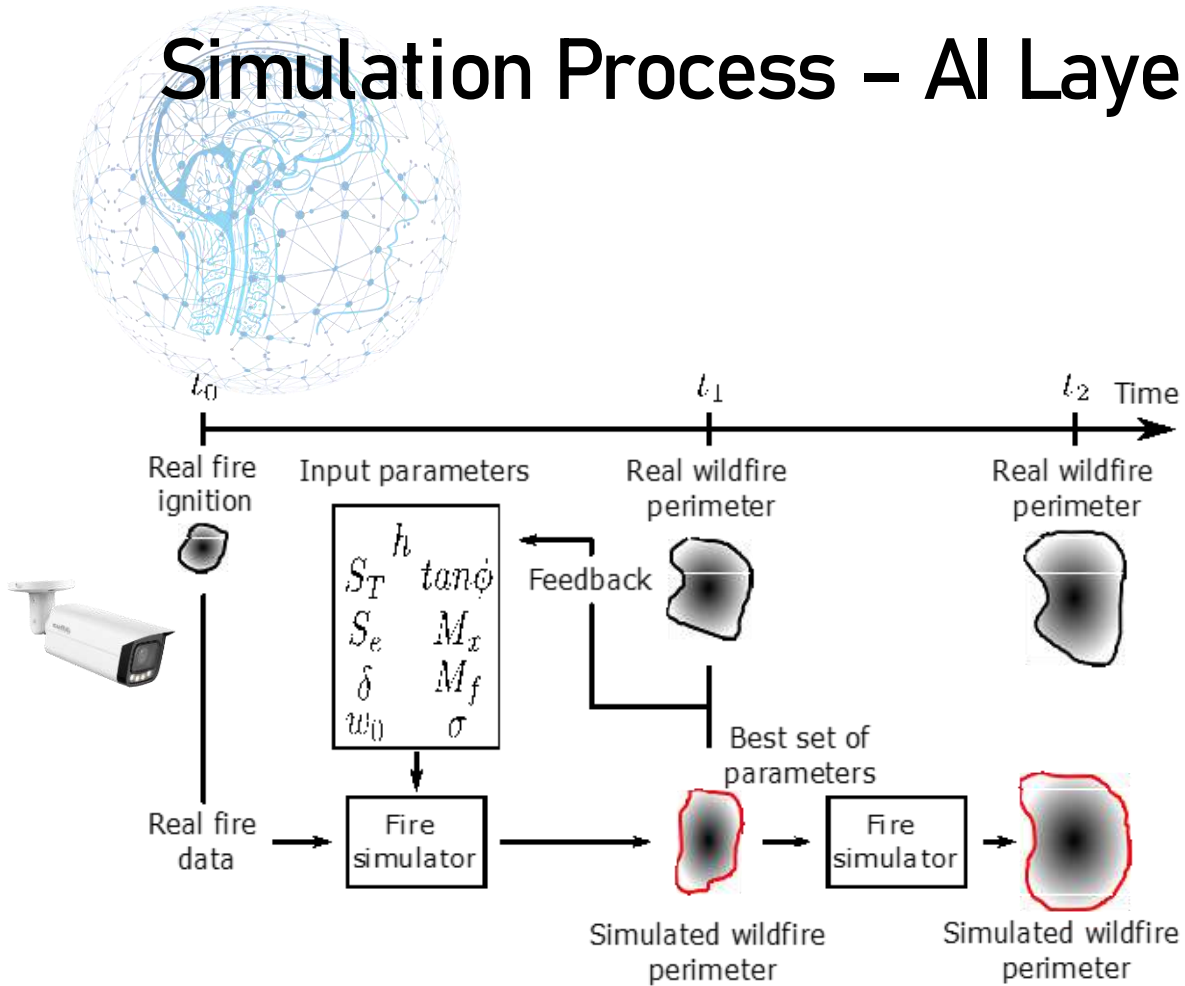Junction Fire   and more...

Bringing more than 30 years of expertise on **fire behavior** to aid in the decision making.
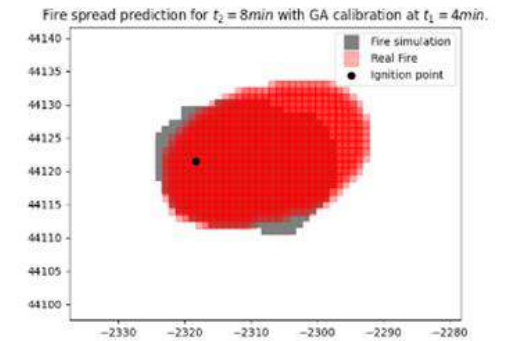
Simulation Process – AI Layer
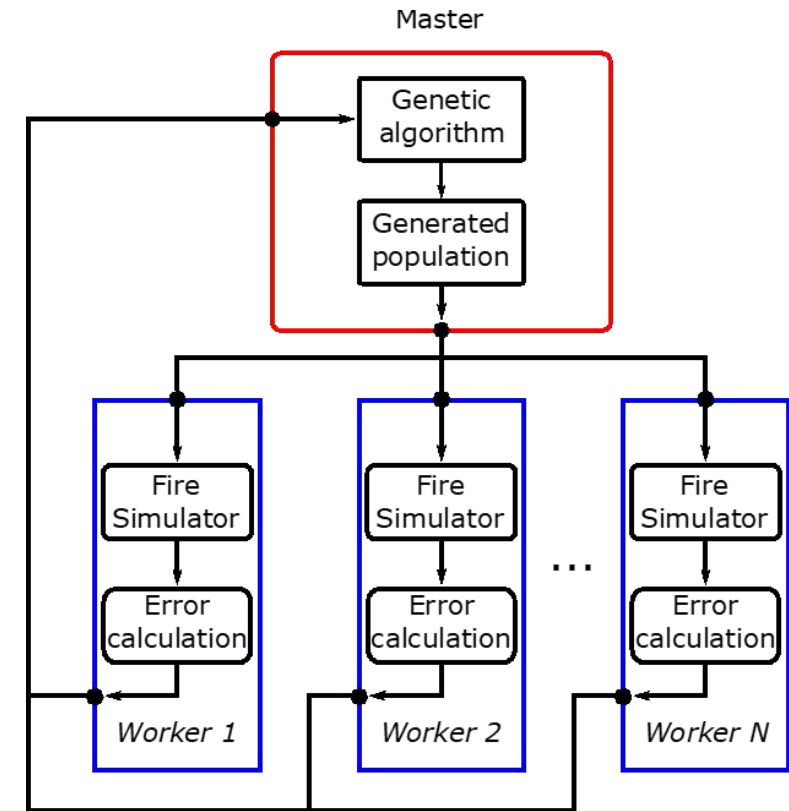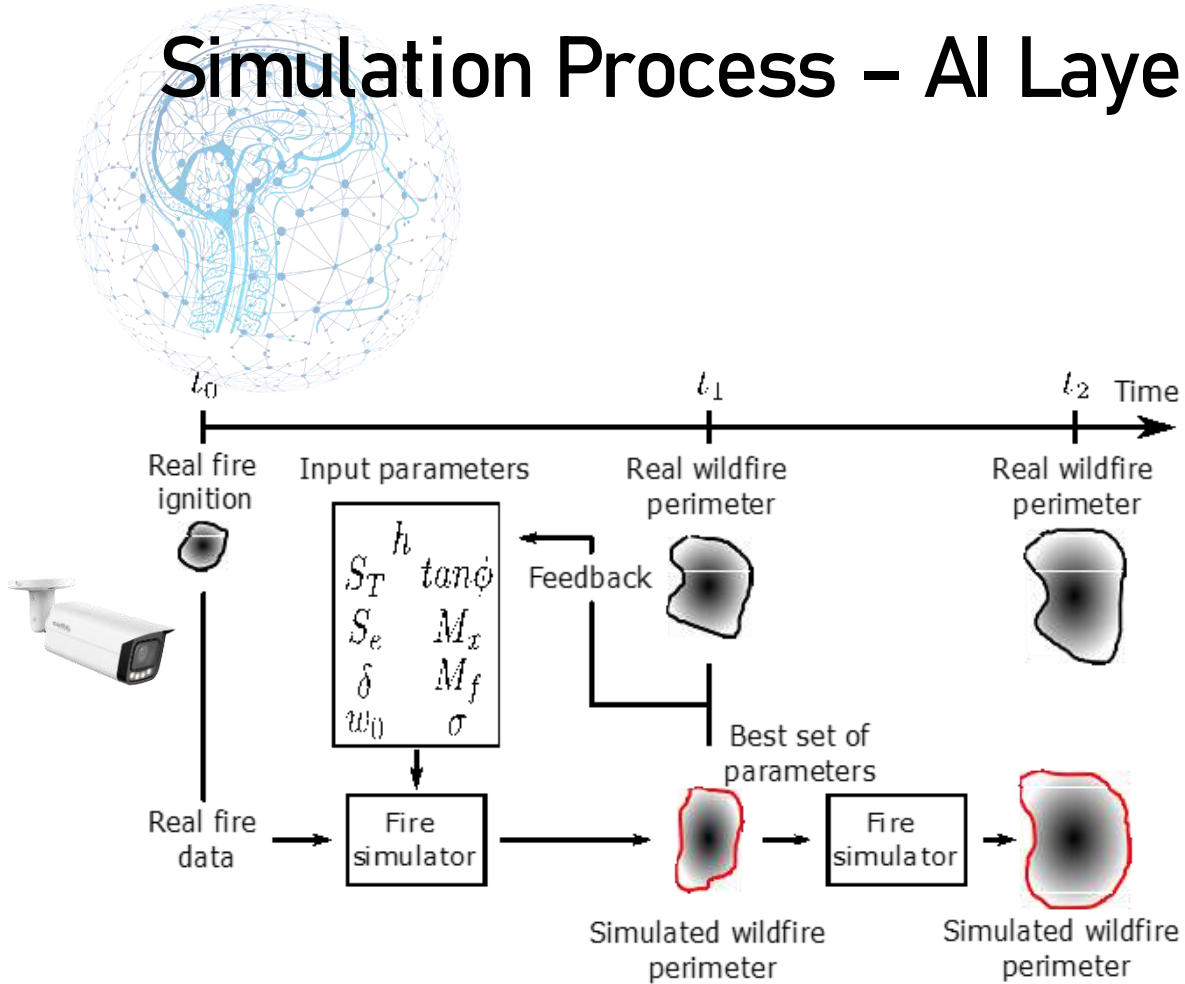
Parallel computing and Algorithm optimization for **increased calculation speeds**
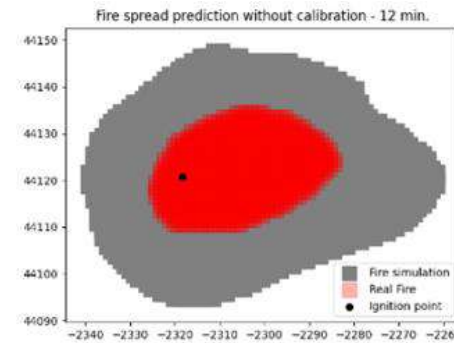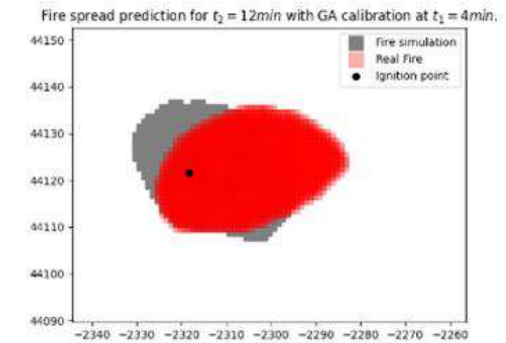
Simulation Process – AI Layer

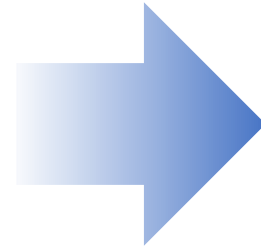

(a) Non-calibrated prediction.

(b) GA calibration.

40% accuracy increase on fire spread results using Genetic Algorithms and parameter fine-tuning.

What's next?

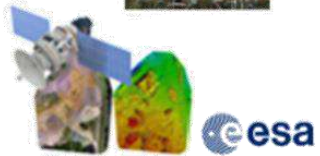**From proof of concept to project scale-up**

6.3M€

2023 ⟶ Dez/2025

Wildfire risk ⟶ Other environmental risks and natural disasters

What's next?

transform

Data collection

Multiple sources

Data processing

Data aggregation and analysis center

Real Time Decision Support System

Decision-making support services and alerts

5 hours

other companies and communities

Thank you!

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