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RFI RETE FERROVIARIA ITALIANA
GRUPPO FERROVIE DELLO STATO ITALIANE

LEVEL SYSTEMS

G.ter
Innovazione in Geomatica

State of the Art

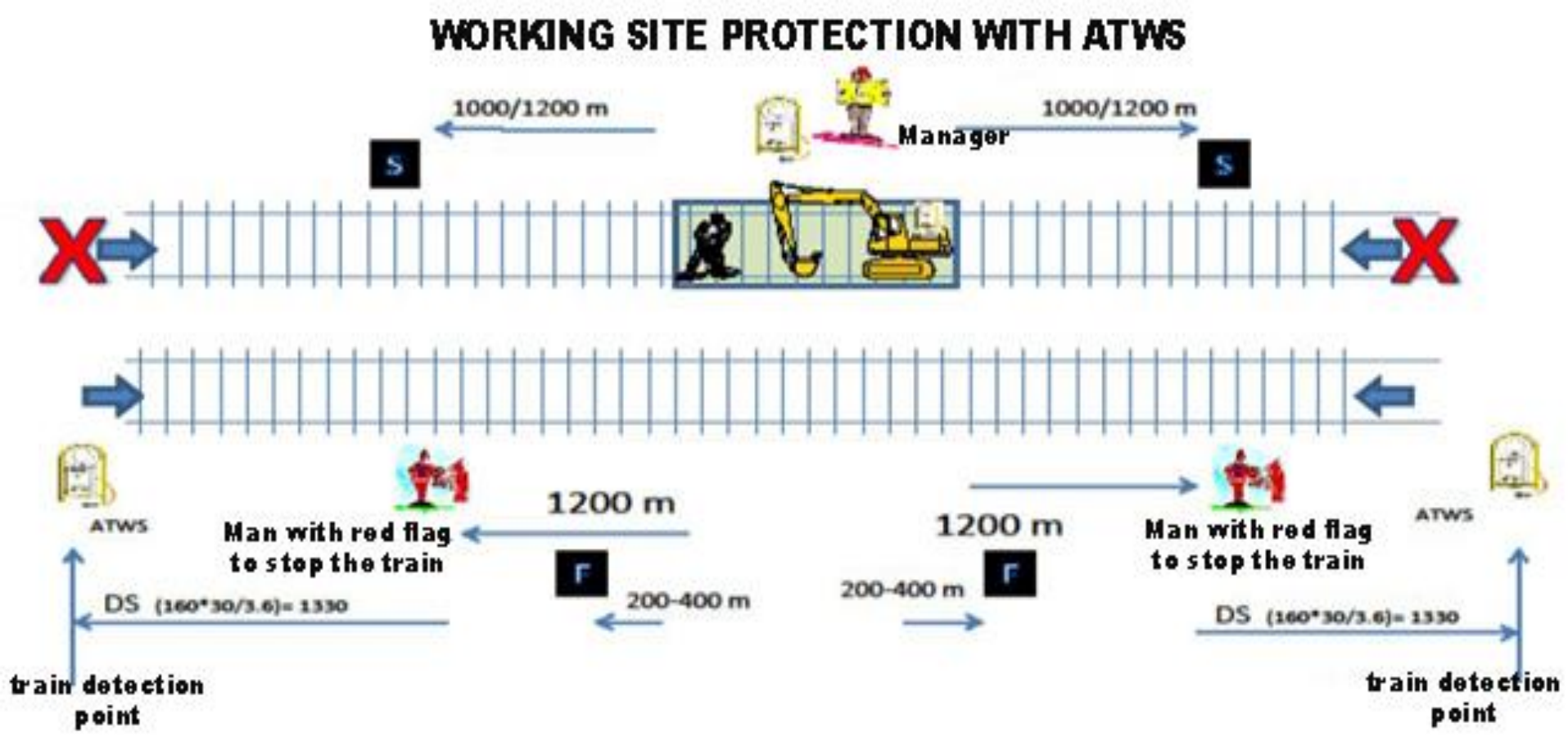
Protection from trains running on the adjacent track is based on **humans procedures** or **ATWS** (Automatic Train Warning Systems):

- **A remote device** to detect trains or **a remote operator** to communicate via radio the presence of approaching trains,
- **A receiving device** able to activate or to communicate to activate an alarm at the worksite,
- **An acoustic and visual alarm to warn the workers** at the worksite,
- **The working area manager who decides on the basis of only his sight that all workers moved in a safe area in short time**
- **A remote signal or an operator** (with a red flag and a radio equipment) able **to stop the approaching train**.

=> Relevant impact of human error.

State of the Art (2)

Automatic Track Warning System.



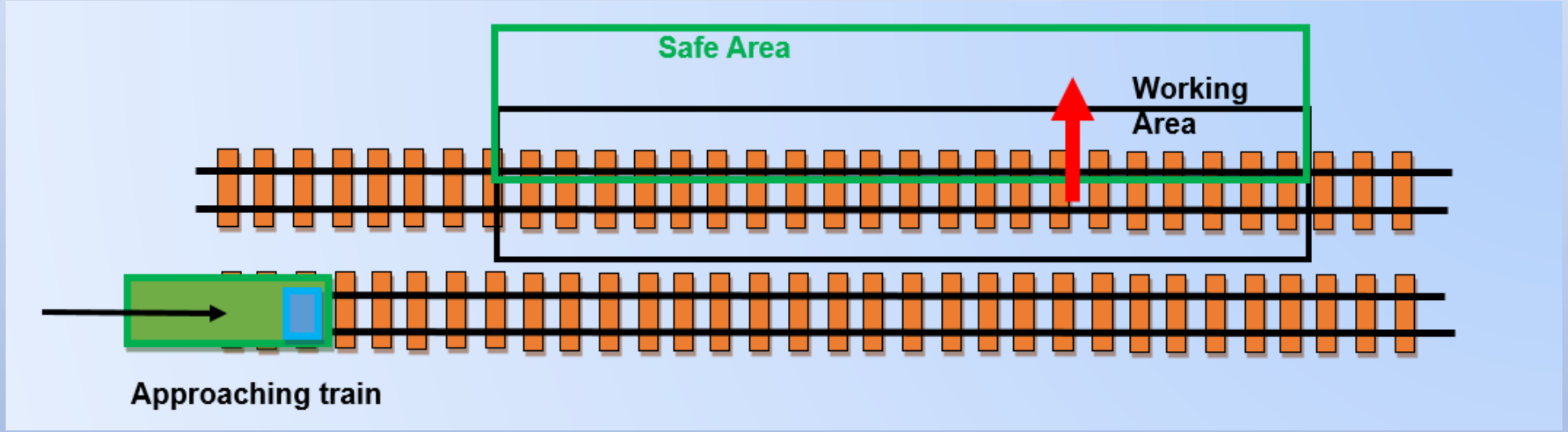
The idea

A **Worksite Protection System** to supervise the **safety of workers** in **railway worksites**.

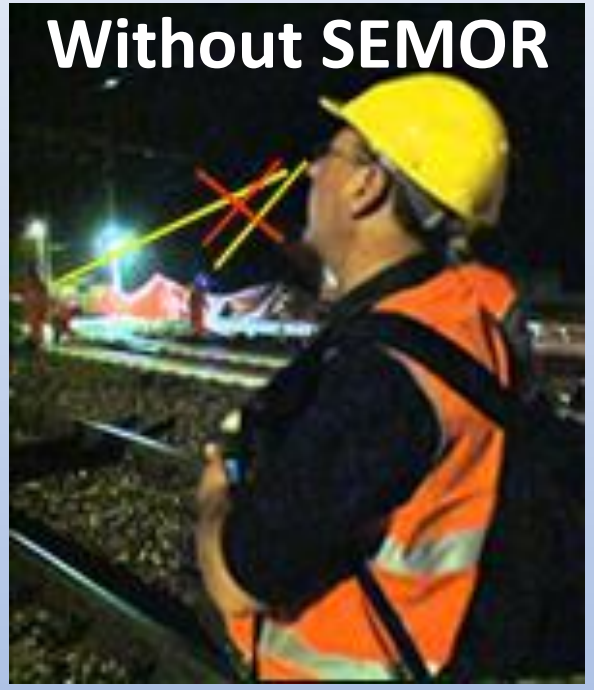
The Project

SEMOR was specified with RFI to be a **Worksite Protection System** able to **overcome the limits of human procedures and ATWS**.

SEMOR now is able to avoid the impact of **human factor in safe decision by** complete **automation** in workers safe localization.

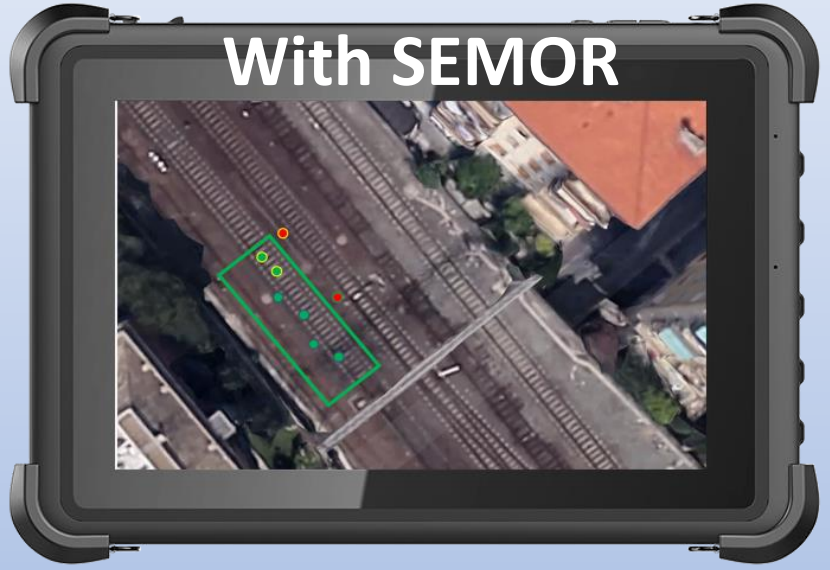


The Implementation



Initial requirements were identified as:

- **Visualization of the safe/unsafe position of workers on the screen** of a device assigned to the working area manager;
- **Real time localization** of every operator;
- **Verify that individually all workers are in a safe position and enable the working area manager to allow the train to pass.**
- Predispose the device to be **directly interfaced with ATWS or signaling systems**.



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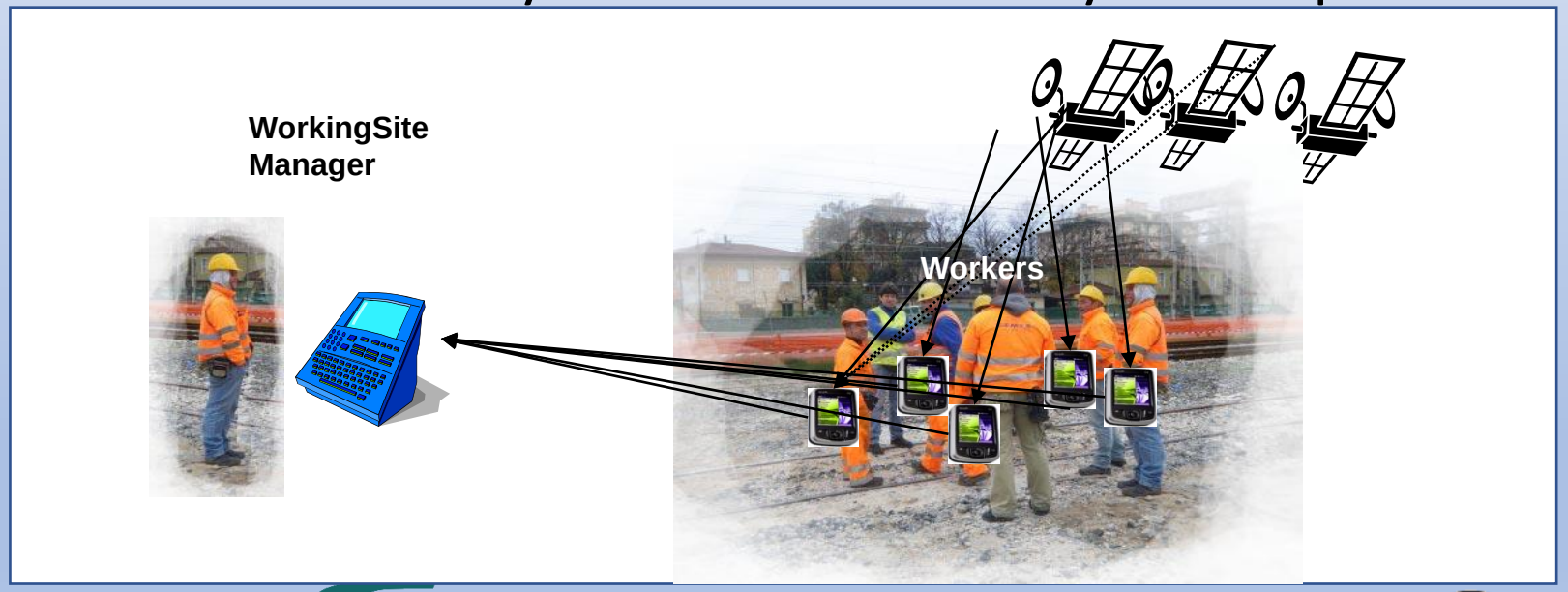
The Prototype

To fulfill these objectives **SEMOR** is based on:

- **Portable individual devices PIDs** assigned to the operators;
- **An intelligent Centre Supervision System CSS** assigned to the Site Manager;
- A **local WIFI network** to exchange information between CSS and PIDs.
- **RTK correction information** by an own device or by subscription.



SEMOR Safe technical requirements

When the train runs on the adjacent track, the **workers must be at a safe distance** (The safe distance is define by national norms as a function of train speed, so the distance of the safe area from the train path is function of norms and error):

- The **coordinates must be guaranteed as true** within a defined error;
- the **positioning error must be known**;
- The transmission of localization data must be protected against unsafe errors: **wrong coordinates and false acknowledgement cannot be received**;
- The **visualization must be protected against unsafe information** and **unsafe train passage authorization cannot be shown** to the Site Manager;
- If activated, **communication to ATWS and/or signalling system must be safe**.

The SW implementation

- The SW development **identified and separated the safe function from unsafe**.
- The safe functions of the prototype were **developed according to CENELEC EN50128** to guarantee the **predisposition to a final product with a defined SIL** (Safety Integrity Level) according to the norm.
- The safe functions were **developed in C according to the CENELEC safe principles** are:
  - **data transmission** of localization and acknowledgement,
  - **workers status** (inside or outside safe area, ack or not-ack) **management** on PIDs and CSS,
  - **visualization of the safe information** (enable the train to pass, alarm active, safe area activated),
  - **predisposition of the communication to ATWS and signalling system**.
- **GIS on CSS is only informative** (the safe info is only authorization) and based on commercial SW, but **protected against freezing**.
- **Satellite data management** is partly developed and partly based on **commercial routine** that can be considered safety proven.

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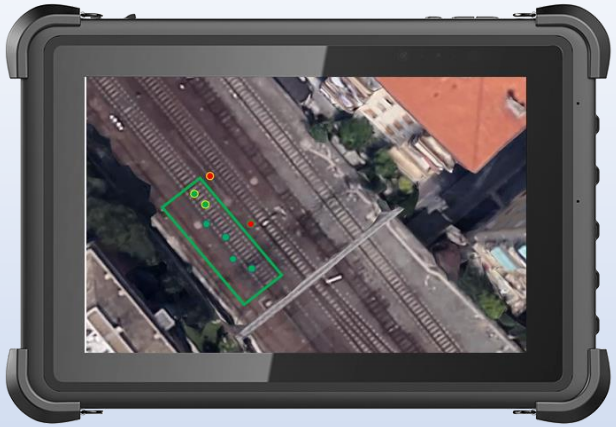
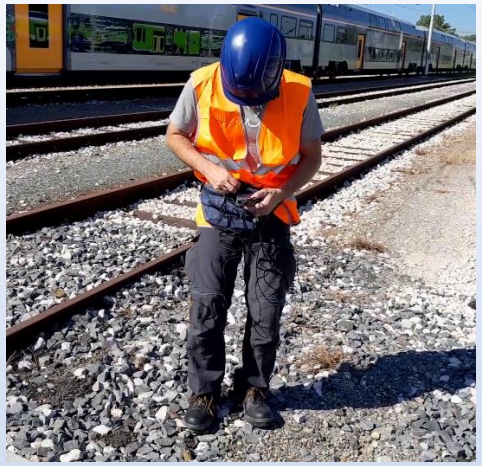
Functional Scenario

- The **train approaches**;
- Line **devices detects the train** and **activate ATWS alarm** in the working site;
- Between the train position and the working site, at breaking distance, **a signal or an adviser with a red flag** is predisposed to **stop the train**;
- SEMOR **CSS activates the safe area**;
- The **PIDs are activated and send localization** to CSS;
- the **CSS shows workers position**;
- A **LED on the PIDs and same colour on the CSS** says if the worker is **outside or inside** the safe area;
- When **inside**, the **led requires to acknowledge**;
- When acknowledged, the **led changes status** and the **CCS shows the Ack status** on the screen;
- When **all have acknowledged**, the CCS allows the **Site manager** to **authorize the train** to pass;
- The **alarm is removed** only when the train is passed.





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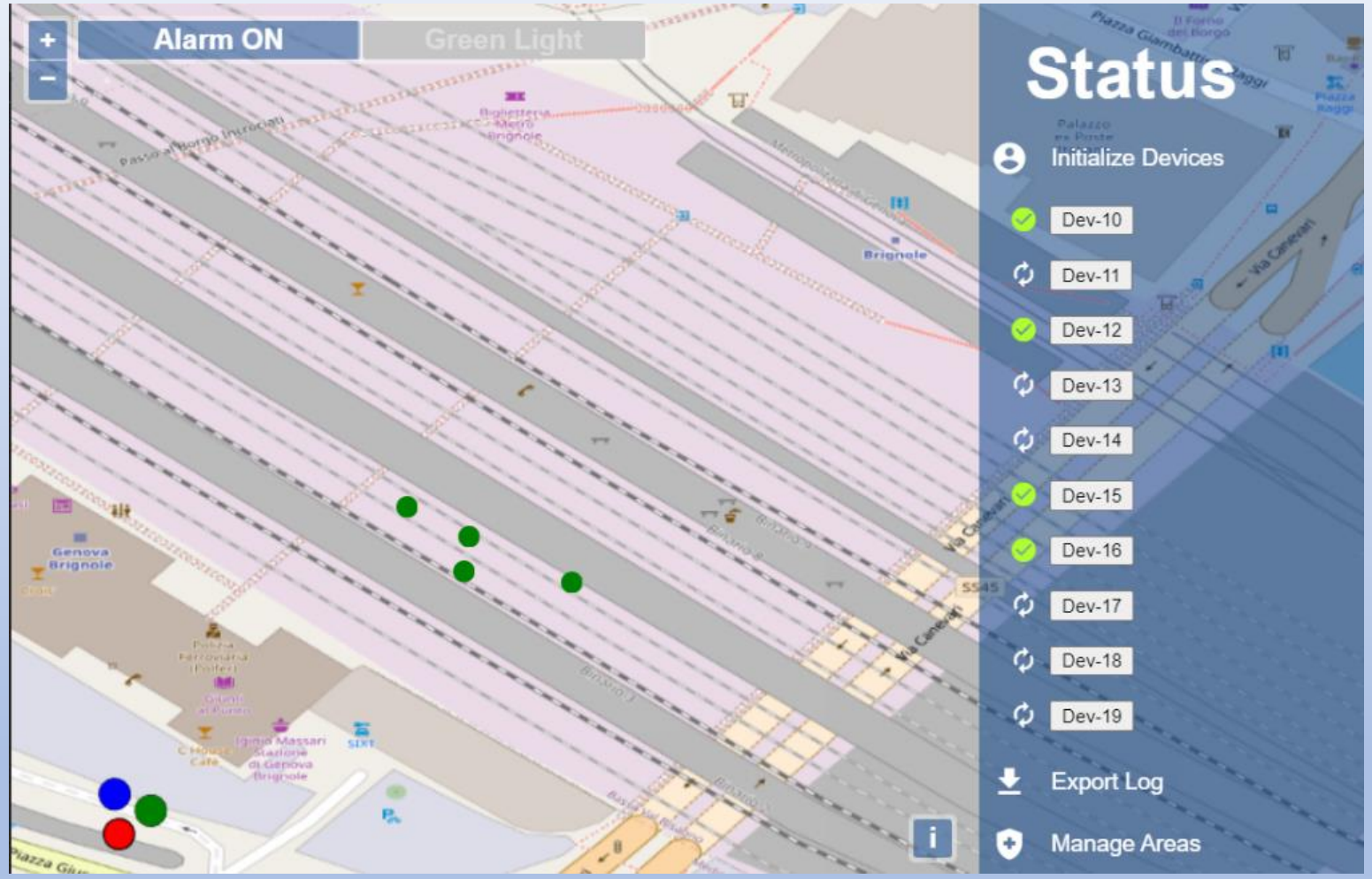
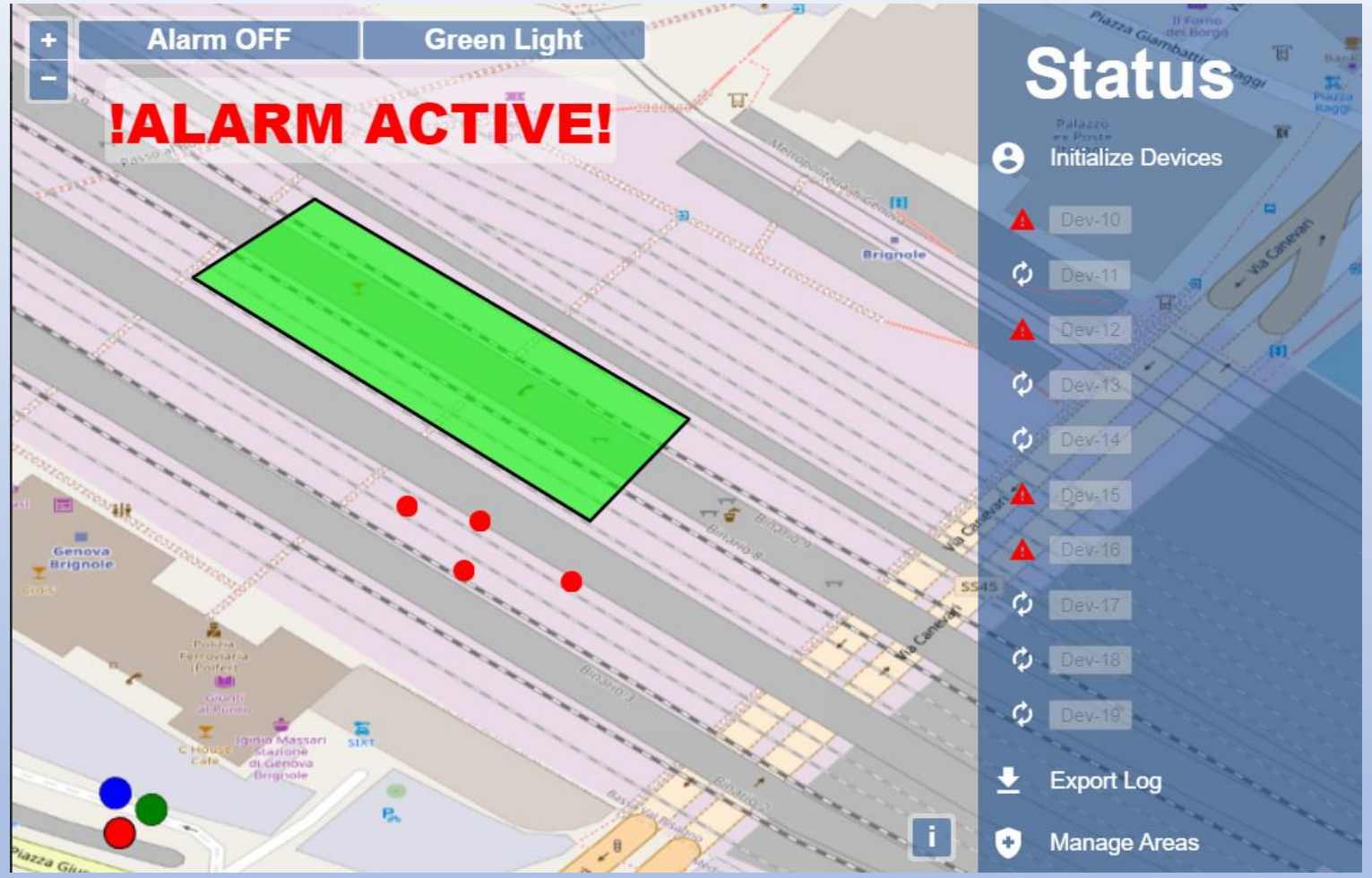
Functional Scenario (2)



No alarm for approaching train.

Workers are represented in **green** (no danger).

Functional Scenario (3)



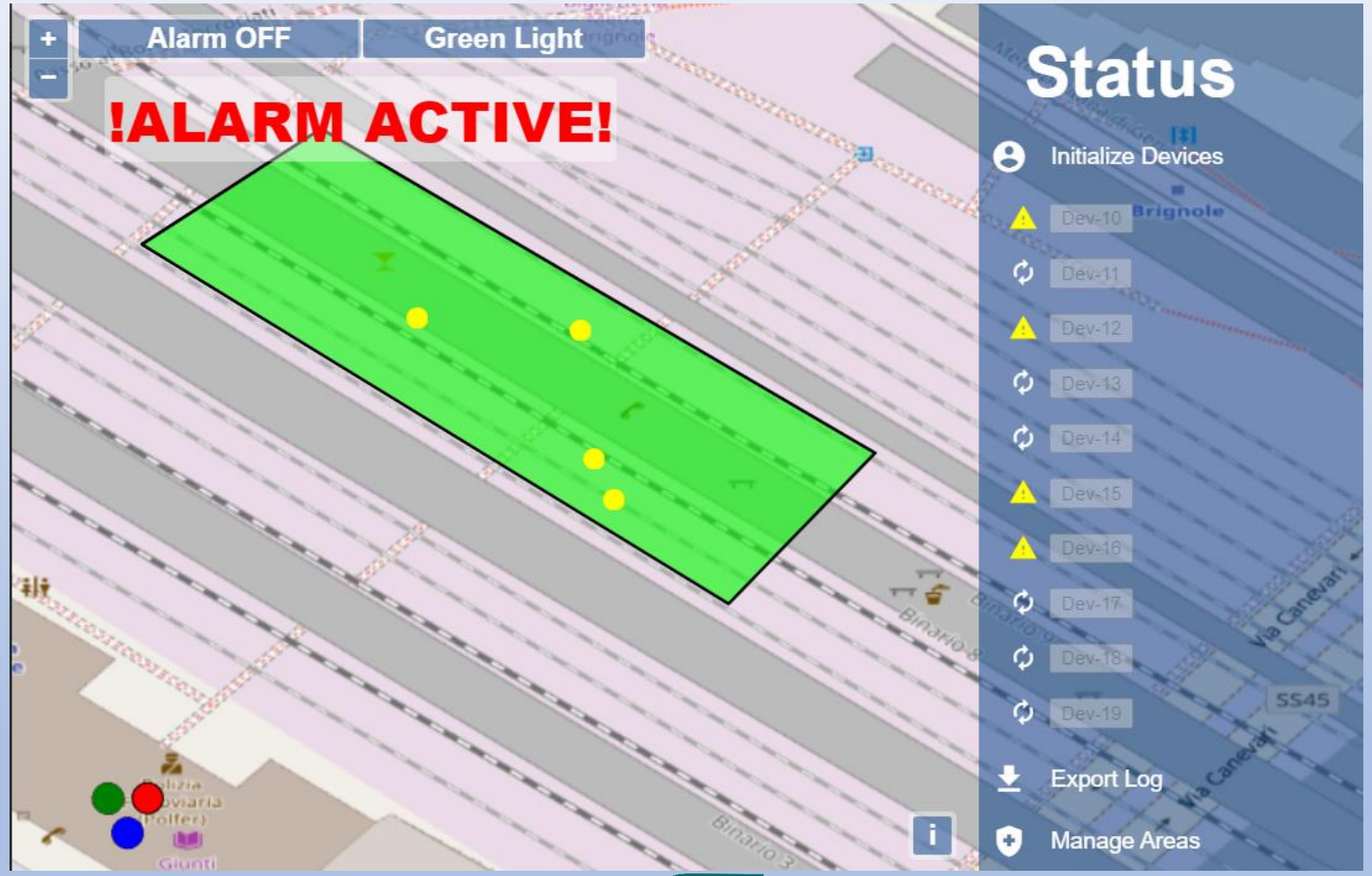
A train is approaching; the **Site Manager activates the safe area**.

The **alarm** is activated **on video**.

The **workers** turn **red**.

At the same time the ATWS's **sound and light alarm are activated**.

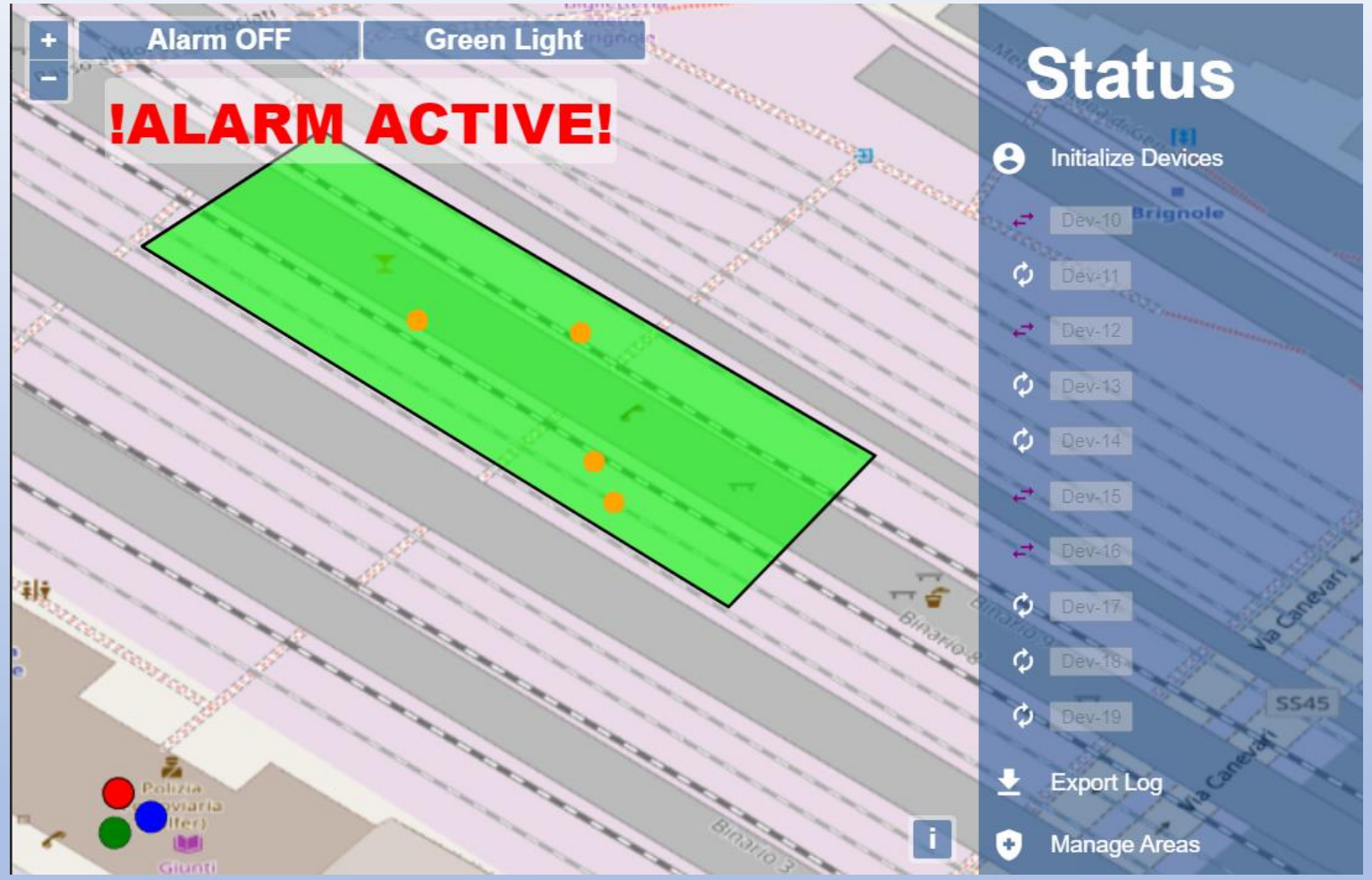
Functional Scenario (4)



Workers move to a safe area.

They have **not yet acknowledged** so they are represented in **yellow**.

Functional Scenario (5)

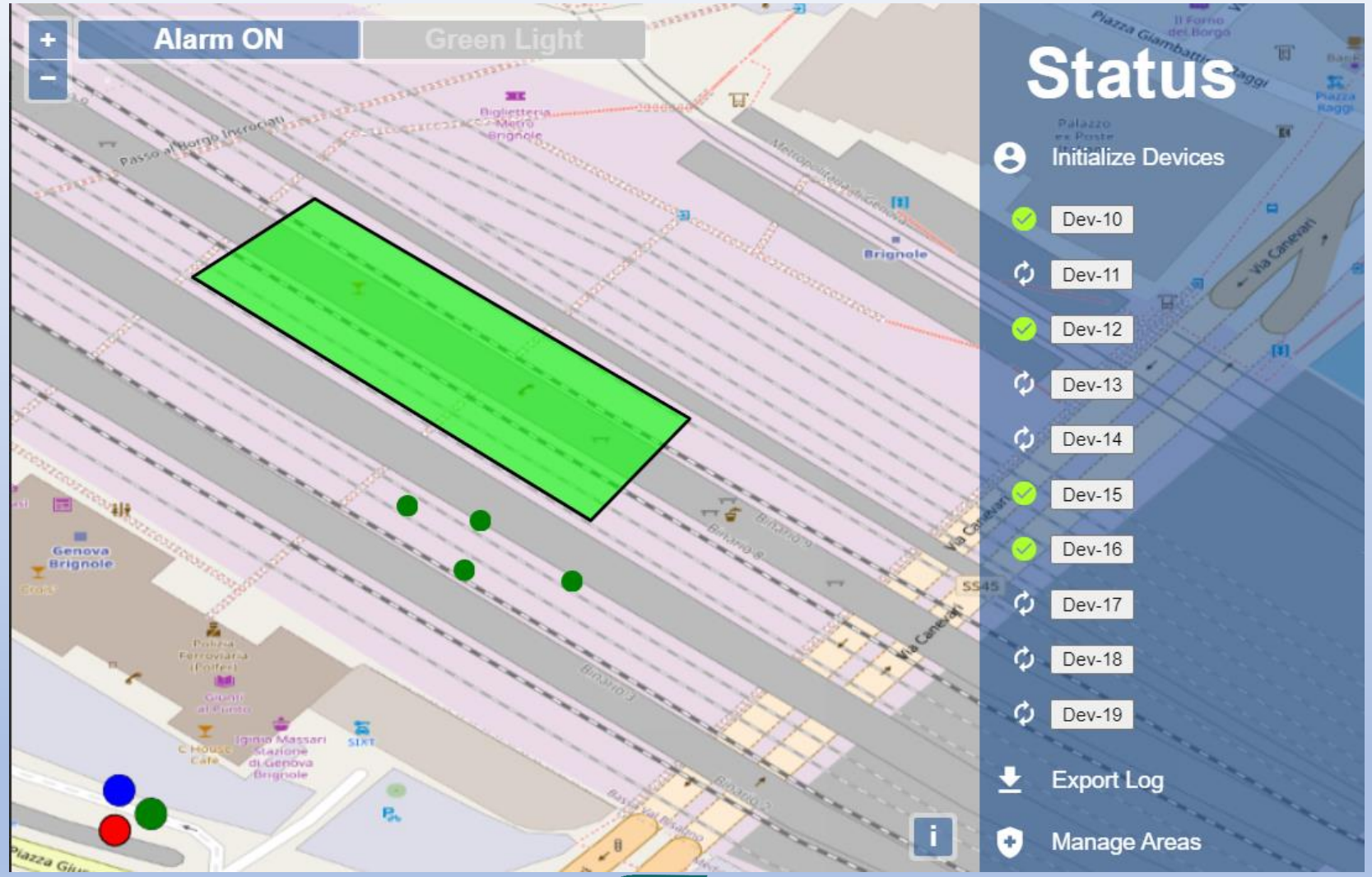


All **workers sent their acknowledgement** by pressing the button or touch.

So they are represented in **orange**.

The **Site Manager authorizes the transit of the train**, but the area and the **alarm remain active until the passage** has taken place.

Functional Scenario (6)



The **train overcomes** the site.

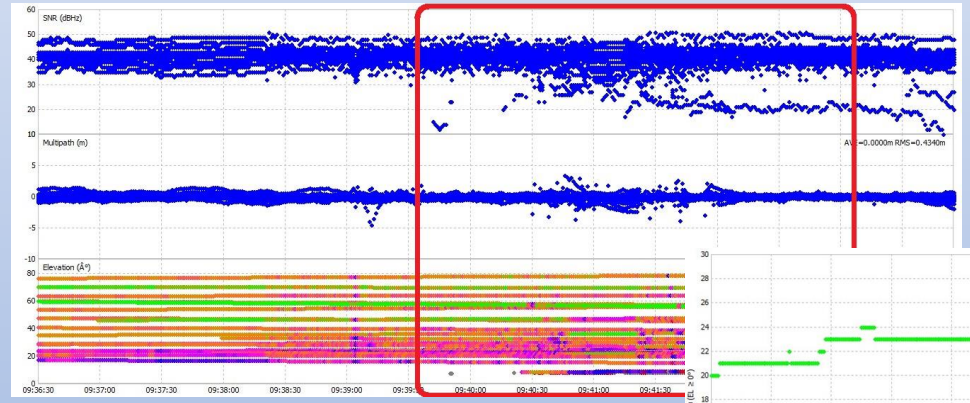
The **Site Manager disables** the ATWS alarm and the SEMOR **alarm**.

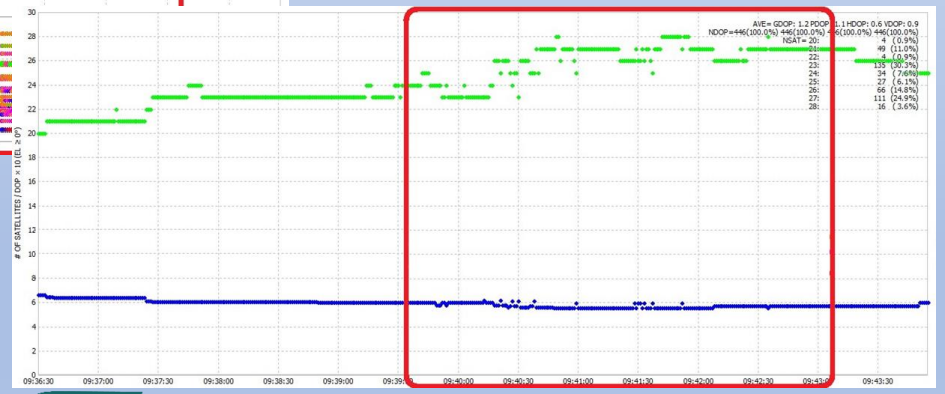
Operators return to the work area, so they are represented in **green**.

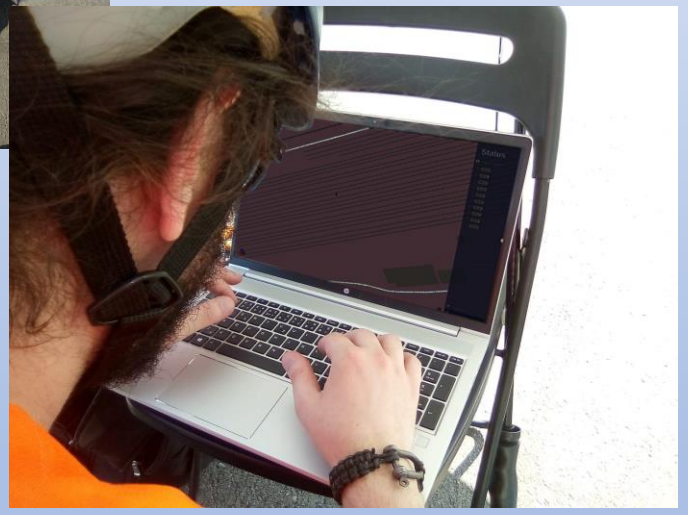
Field tests

The test have been performed successfully in the ***experimental Site of RFI in San* Donato** and in the **railway station of Genoa** Brignole.

High quality was reached also in disturbed conditions.







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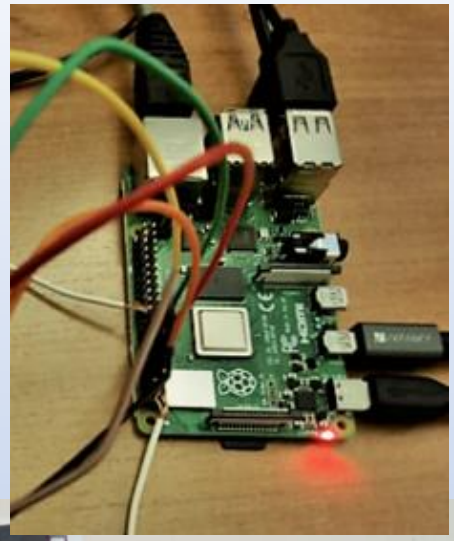
Future developments: HW upgrade

A **new safe boards** should be individuated or developed:

- with **small footprint and size requirements** good for wearability in a working site environment,
- Able to guarantee the **required SIL,**
- Able to be approved by a **railway safety assessment**.



Future developments: SEMOR 3D

The evolution of SEMOR must overcome its **actual limitations and weaknesses**.

The main limitation is the need of **good visibility of satellite constellations is required** for Decimetric Localization.

Along a Railway line, complex **morphological and architectural conditions** cannot guarantee the **needed visibility**.

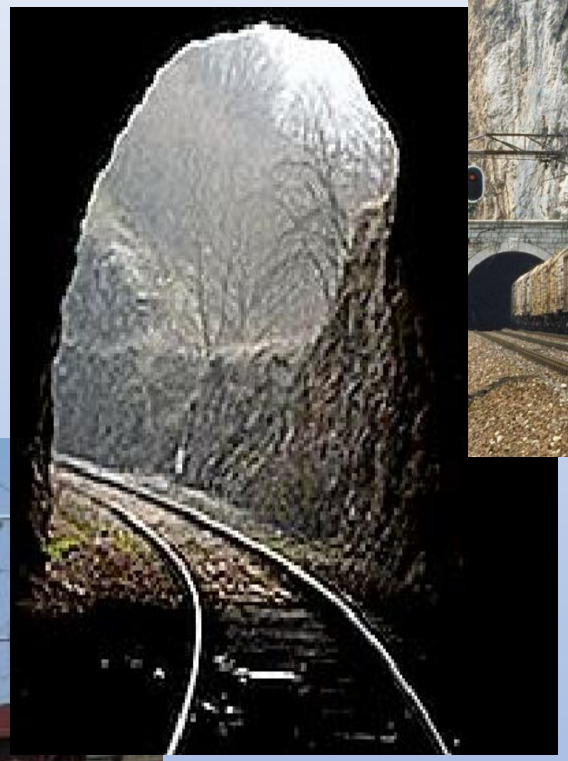
Weak Satellite Coverage can be a **common situation** on the European the railway network.

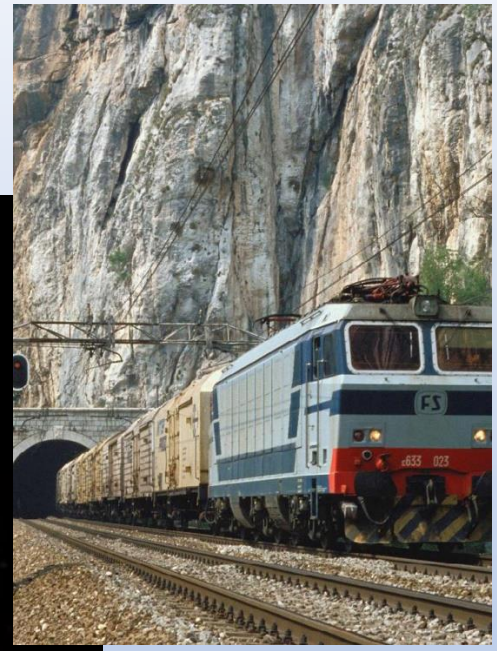
Future developments: SEMOR 3D (2)

SEMOR 3D is the new ESA project to resolve weak satellite coverage.

Typical scenarios could be:

- **mountain canyon**,
- **tunnels**,
- but also **big yard** and **railway station** full of **metallic disturbing objects** as portals of the railway electrification.





The market: a modular approach

Possibility of **different possible modes of integration** in the safety of the
railway maintenance process:

1) **Human Procedures without technologies**: SEMOR supports the Site Manager who stops the train by a radio message to the operator with
the flag;
2) **Human Procedures + ATWS**: SEMOR supports the Site Manager who stops the train by closing the signal by ATWS;
3) **ATWS safe integration:** an ATWS/SEMOR safe interface allows info exchange to automatically control
the trackside signals without human intervention;

The market: a modular approach (2)

1) **Signaling safe integration:** an IXL safe interface allows info exchange with SEMOR to automatically control the trackside signal without human intervention;
2) **ERTMS:** SEMOR communicates directly with the ERTMS Radio Block Centre.