E-PreS: Evaluation of Building Evacuation Drills

An EU Co-Funded project

Contract Number: ECHO/SUB/2014/698447

http://e-pres.di.uoa.gr

http://p-comp.di.uoa

Coordinator and Partners

- University of Athens, Greece (Coordinator)

- Earthquake Planning and Protecting Organization, Greece (EPPO, participant)
- University of Crete, National History Museum of Crete, Greece (NHMC – UoC, participant)
- Istituto Nazionale di Geofisica e Vulcanologia sezione di Napoli Osservatorio Vesuviano (Vesuvius Observatory), Italy (INGV, participant)
- Center for Educational Initiatives, Bulgaria (CEI, participant),
- National Institute for Research and Development in Construction, Urban Planning and Sustainable Spatial Development, "URBAN-INCERC", Romania (INCD-"URBAN INCERC", participant)

Objective

- To develop a trustworthy portable system which will enable the evacuation drill organizer to benchmark the evacuation process, pinpoint the evacuation scenario weak points and take remedial actions by modifying it. We focus on school evacuation drills due to earthquake, flood or volcanic eruption.
- To improve evacuation awareness among students and the community.

The E-PreS Architecture

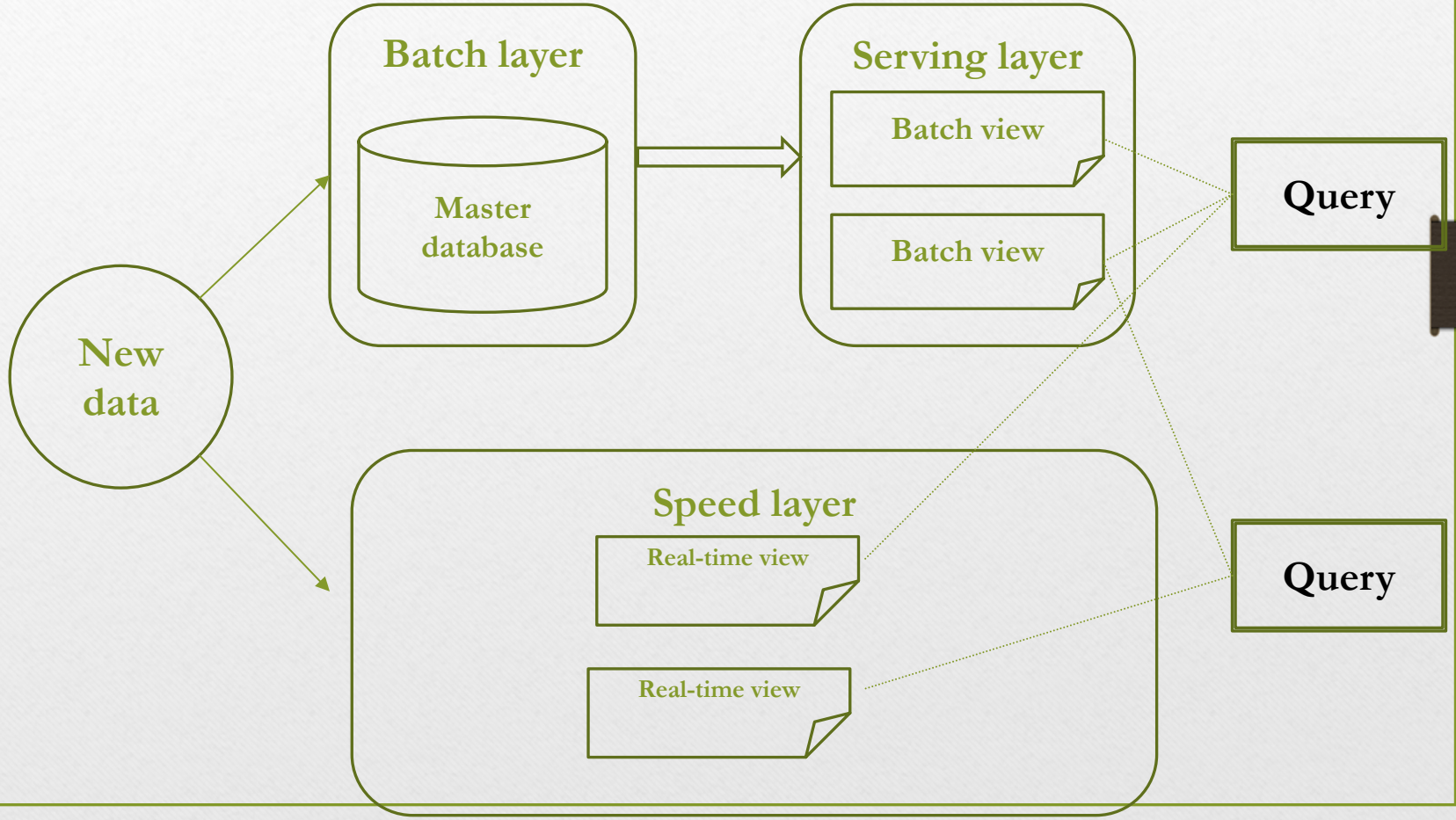
- Sensor
- Data stream
- Data processing
- Service
- Web application

Components

The E-PreS Architecture

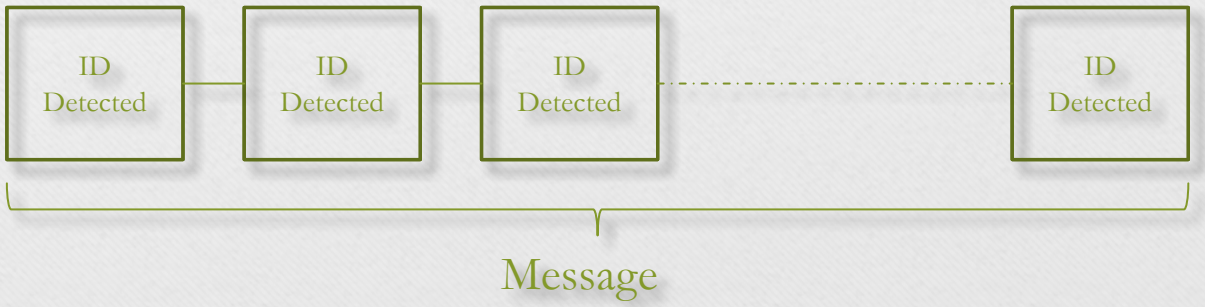
- Sensor components
  - Include all components that operate inside a sensor unit.
- Data stream components
  - Act as an intermediate level between the sensor and processing components and handle the data flow.
- Data processing components
  - Process the data provided by the data stream components
- Service components and web application components
  - They are related to user interaction with the system (e.g., through a web browser the user is able to perform evacuation drill trials and make decisions)

Data processing Architecture (modified λ-architecture)



Sensor components

- **Sensors are identifiable**
- **Their readings and messages are available on demand**
- **Messages and readings can be stored and retrieved**



Reader interface

- It receives data from the sensing hardware connected to the sensors
- Extracts required information
- Transforms the information to a message pattern
- Transmits the message to the message queue

Sensor message queue

- Maintains the messages for a sufficient amount of time before transmitting them through the network
- Ensures fast and reliable message delivery

Data stream components

- Run on the mobile server, receive data from the sensors and deliver it to the other components of the server.
- Handle massive amounts of data.
- Comprise of a message queue and a message broker far more powerful from the queue on the sensor layer.
- It is fast, reliable and able to repeat the process of receiving and transmitting messages.
- Routes the incoming messages to batch and speed layer.

Server message queue

- **Receives messages simultaneously from different sources.**
- **Maintains the messages for an adequate amount of time.**

Batch layer – Persistent data storage

- **It stores all data received. The Persistent data storage receives all the data from the Message Broker concurrently with the speed layer, storing them for read-only operations.**

Serving layer - Database

- Stores all the data that is needed from the application or the users.
- Provides insert, modify and delete operations for the actual data.
- Answers to queries.
- Creates and answers queries of the real-time feed
- Provides administration permissions to other components and/or users

Service components

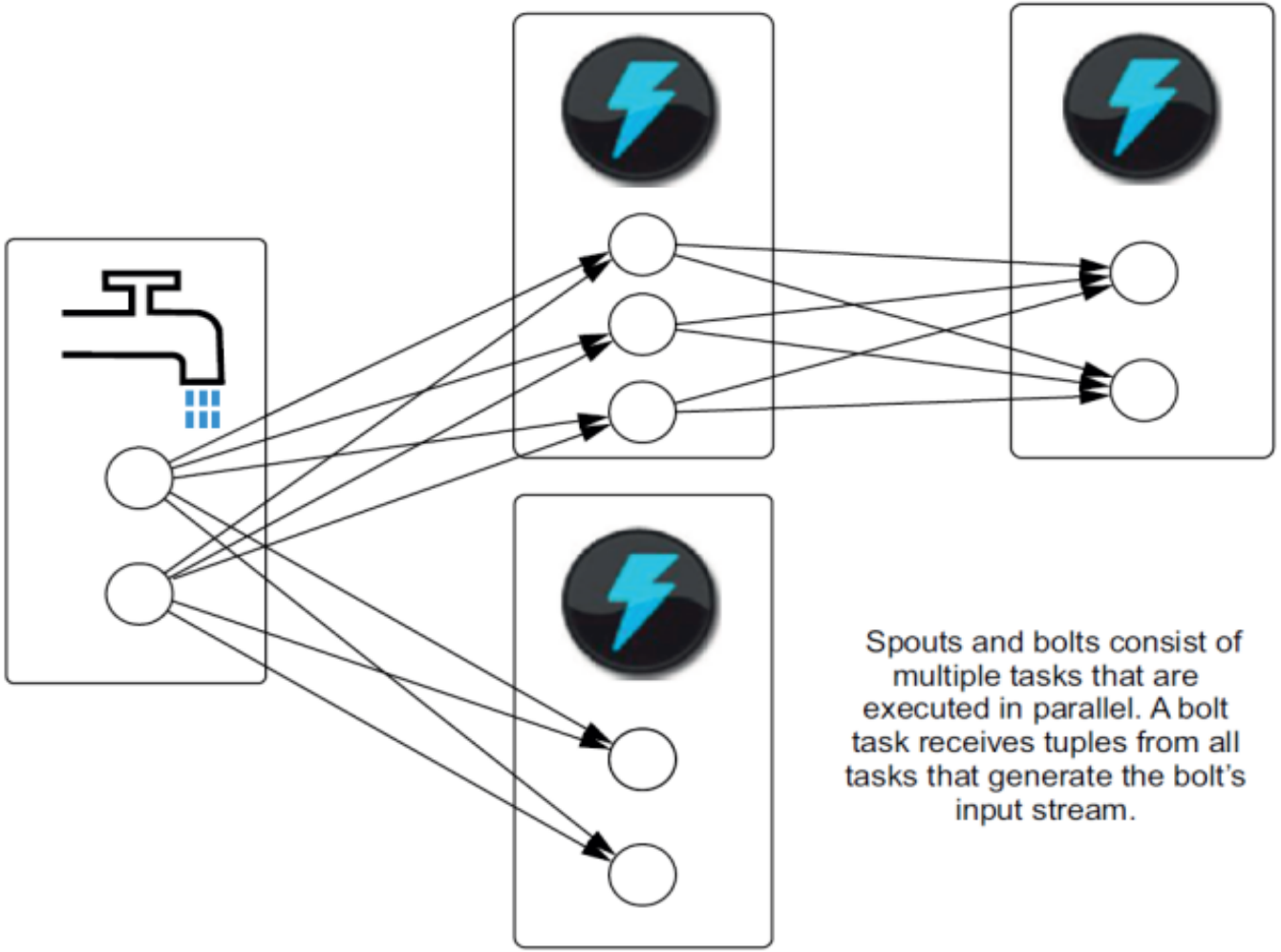
- **Provides functionalities for web application components (e.g., data analysis, registration services etc.)**
- **All components run in the web application server, developed in a server-side scripting language.**
  - Real Time Service
  - Data Analysis Service
  - Registration Service
  - Security Service

Web Application Components

- Drill Registration/Modification Component
- Drill Review Component
- Real-Time Monitoring Component

Storm topology

- A single piece of software that is deployed across a cluster.
- A single executable filters data in one node, computes aggregates with a second node, and updates real-time view databases with a third.
- Spout-Bolt abstraction: Spouts (streams) – Bolts (actions on streams. They produce streams themselves).
- Very low latency (less than 10ms).
- Focuses on business logic instead of coding for separate modules.



Spouts and bolts consist of multiple tasks that are executed in parallel. A bolt task receives tuples from all tasks that generate the bolt's input stream.

Use cases: The E-PreS System

User

Provide Credentials

Verify Credentials

Reject User

Create Drill

Modify/ Delete Drill

Review Drill

Blueprint

No of Students and Staff

Antennas' position

Date and Time of Drill

Blueprint

No of Students and Staff

Antennas' position

Date and Time of Drill

No of Students and Staff

Antennas' position

Date and Time of Drill

Results

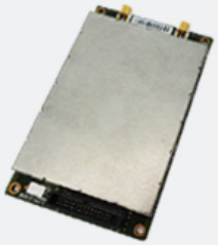
Review Drill

In a nutshell

- **Before the drill:** Blueprints of the building are uploaded in the database. Checkpoints are set at strategically selected points and all related information is registered (e.g., number of students per classroom, maximum flux per checkpoint, etc.)
- **During the drill:** Nodes are deployed at the building, powered up, the system software is started, Wi-Fi network is established and the nodes are registered at the system.
- The drill is kick-started, the data collected provide the real-time view and are simultaneously stored for later processing.
- **After the drill:** master database is updated

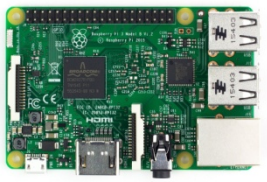
Overview of the equipment of a node (checkpoint)

2 Antennas



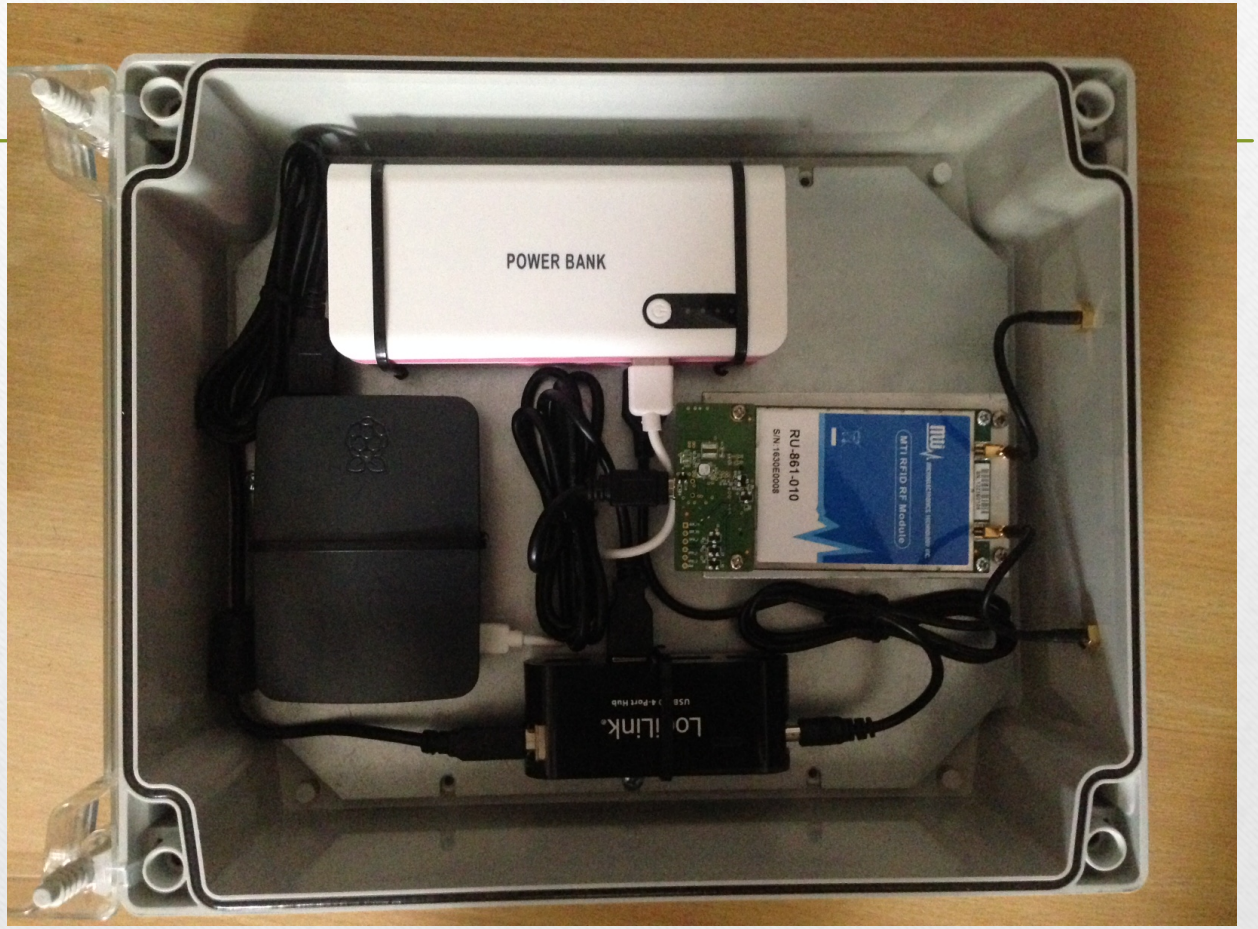
RFID Reader

Power Banks

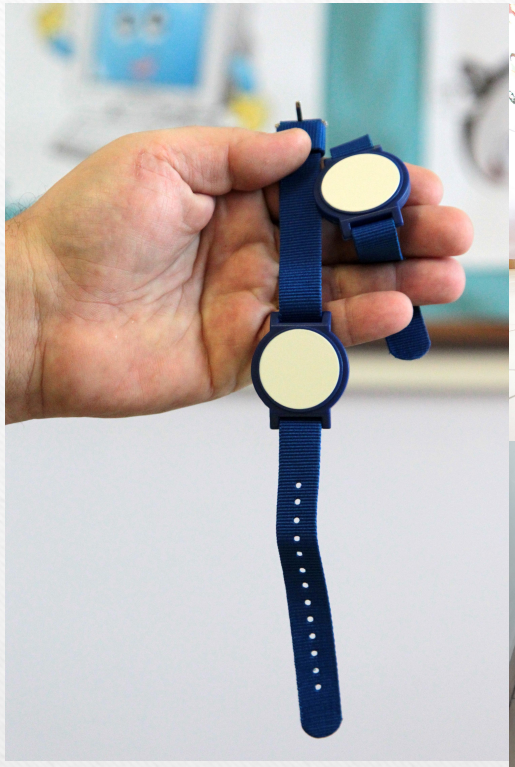


Board Computer
(Raspberry Pi 3)

Overview of the equipment of a node (checkpoint)



RFID tag placement



Node placement in a school

Node placement in a school

Node placement in a school

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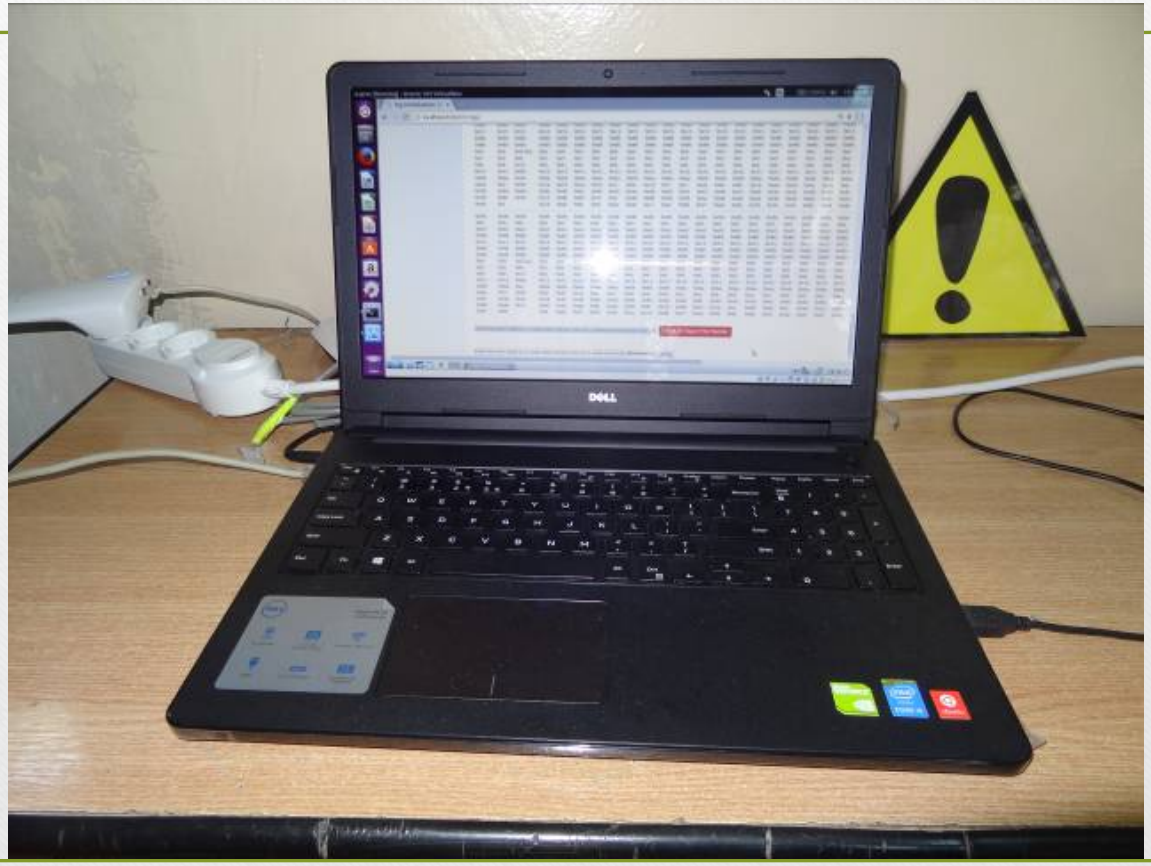
Node placement in a school

Server running on a VM on a Linux laptop

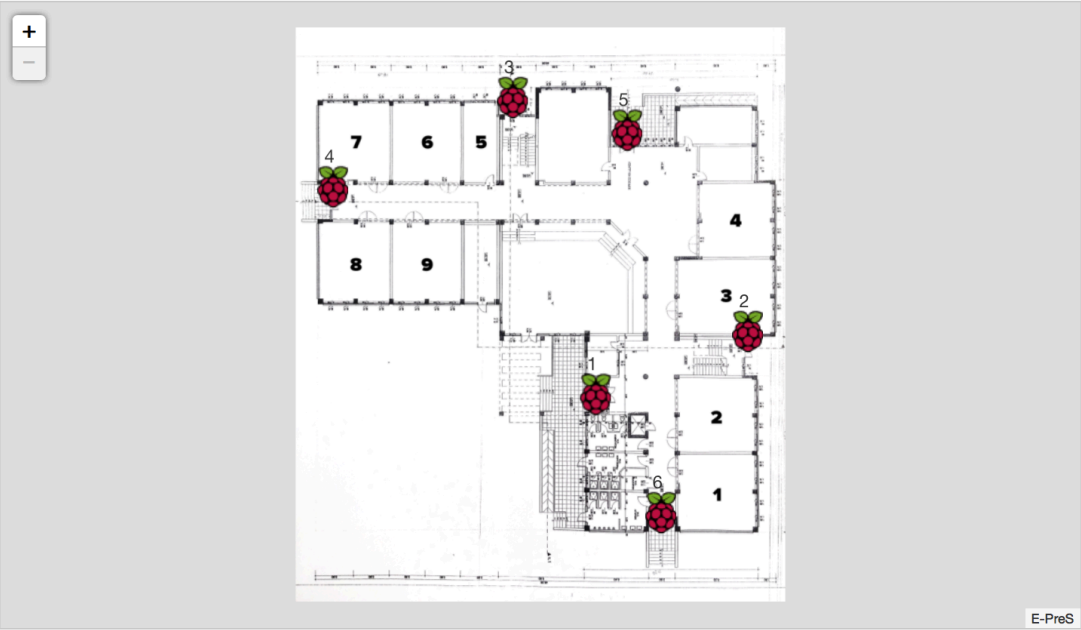


Desktop View

Update Building Settings

3lyktrik

Click on the floor map to insert checkpoint, fill out the form on the right, press save when you are done. Repeat for up to 10 checkpoints.



Ground Floor (Ισόγειο)

1	Flux	Exit No 1	IsExit?	Update
2	Flux	Exit No 3	IsExit?	Update
3	Flux	Exit No 4	IsExit?	Update
4	Flux	Exit No 5	IsExit?	Update
5	Flux	Central Exit	IsExit?	Update

X

Desktop View

Classroom 10 (Αίθουσα 10)

← Back to Building Details

Update Path Settings

Delete Path

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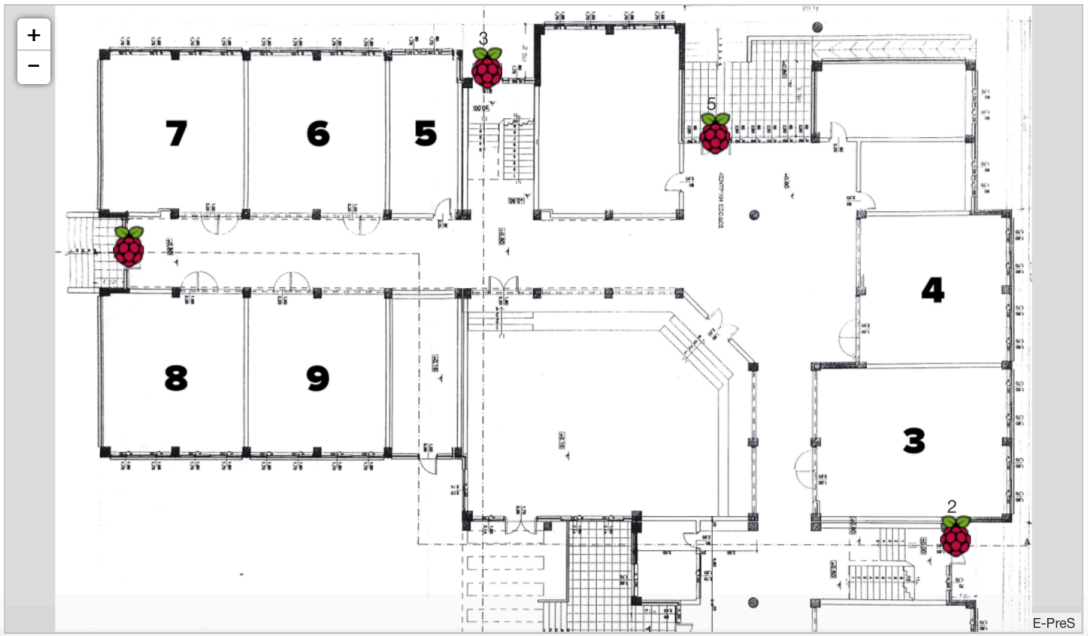
Click subsequent checkpoints on the floor maps to define the evacuation path followed by evacuees. On the right press save when you are done.

Ground Floor (Ισόγειο)



Other Paths of the Experiment Earthquake evacuation drill #1

- Classroom 11 (Αίθουσα 11)
- Classroom 12 (Αίθουσα 12)
- Classroom 13 (Αίθουσα 13)
- Classroom 14 (Αίθουσα 14)
- Classroom 15 (Αίθουσα 15)
- Classroom 16 (Αίθουσα 16)
- Classroom 18 (Αίθουσα 18)
- Classroom 1 (Αίθουσα 1)
- Classroom 24 (Αίθουσα 24)
- Classroom 2 (Αίθουσα 2)
- Classroom 3 (Αίθουσα 3)
- Classroom 6 (Αίθουσα 6)
- Classroom 7 (Αίθουσα 7)
- Classroom 8 (Αίθουσα 8)
- Classroom 9 (Αίθουσα 9)

Evacuation Path Name*

New Evacuation Path

Evacuation Path

Save

Clear


post-execution/
INGV-Primary School
ion Paths 8
Checkpoints 5
Total Time (sec) 136
Basement
id Name Max Flux
1 Secondary Exit -
118
2 min
Ground floor
id Name Max Flux
2 Main exit -
3 Classrooms corridor -
4 Secondary stairs -
First floor
id Name Max Flux
5 Main stairs -
E-PreS
Trial Version
lenovo

Field trials

- EPPO (10/11/16 & 23/11/16)
- NHMC – (22/11/16 & 25/11/16)
- INCD – (24/11/16)
- CEI – (21/10/16 & 25/10/16)
- INGV – (7/11/16 & 30/11/16)

Field trials results

- The system worked as expected. No problems reported whatsoever, apart from occasional Wi-Fi network outage.
- A Wi-Fi router could be used instead of Wi-Fi-repeaters to ensure system robustness.
- The portability and use of the system in remote schools without Internet Connection was demonstrated.

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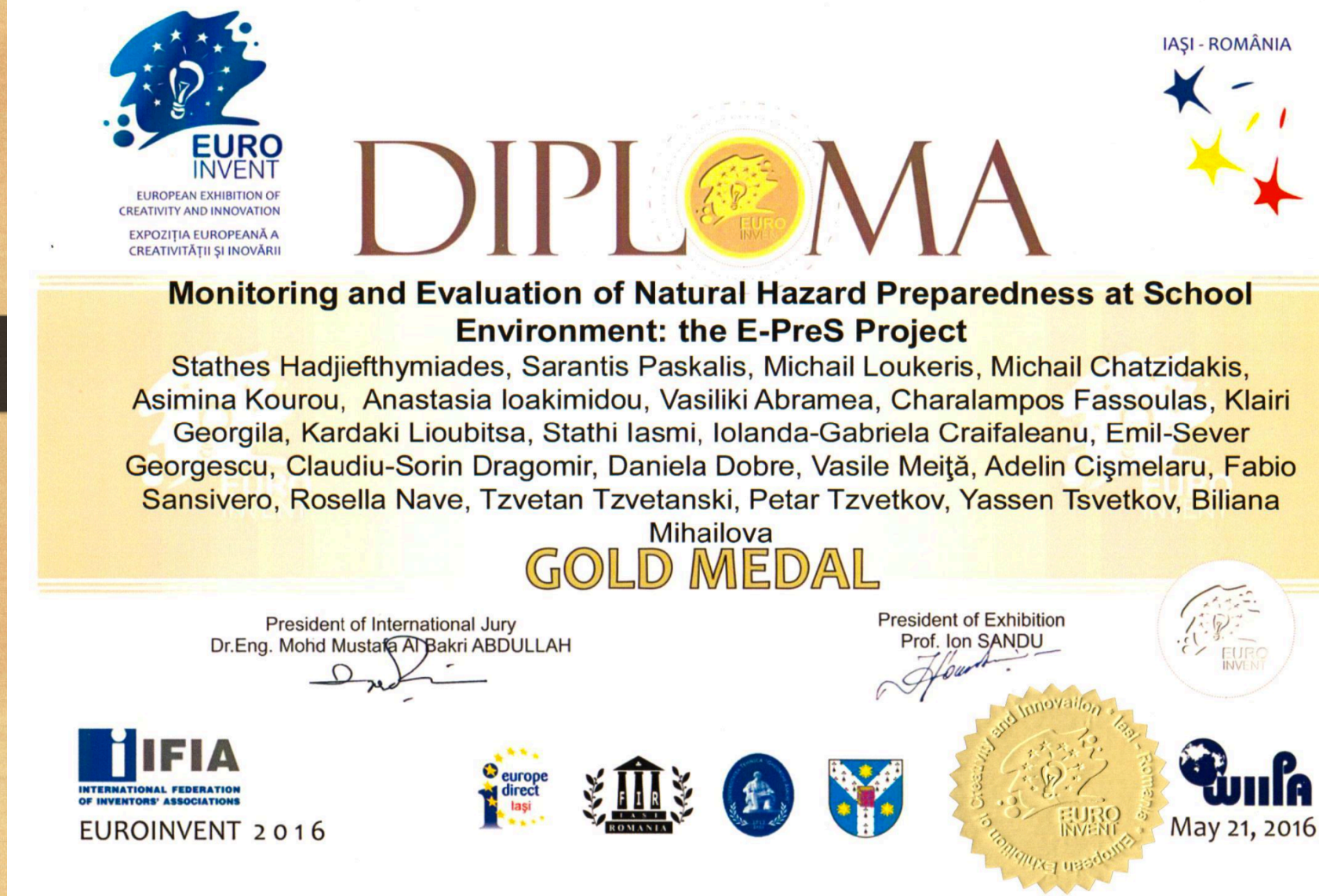
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Thank you for your attention!

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