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Integration of Rescuetrack into the International Standard Accident Number System

Bachelor's Thesis Proposal

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1 Introduction

Despite today's technological development, rescue chains are still limited to manual processes, and humans being the main actors in rescue operations [1]. These can lead to undesirable results, as the victims in accidents are often unconscious and are actually in need of a second person to recognize and report the event [2]. Then the responder to the emergency call has to get the relevant information and dispatch the appropriate rescue team [2], which leads to delays and could also be vulnerable to miscommunication or language impediment of the reporter.

With the growth of the Internet of Things (IoT), emergency calls no longer have to rely only on human intervention. Smart wearables, cars, or homes can detect accidents and medical emergencies in real time and generate autonomous alerts [3]. These devices can communicate essential details such as location and vital data with the rescue service and the emergency department in the hospital, giving a better understanding of the situation and reducing delays and the risk of human error. However, there is no general methodology for connecting the isolated Information and Communication Technology (ICT) systems of the involved parties in this communication [2].

For this reason, the International Standard Accident Number (ISAN) communication platform [1] was introduced to link and enable data exchange between isolated systems, avoid data misinterpretation, and integrate additional data sources.

This platform (Fig 1) consists of an Alerting System (AS), which represents the ICT systems at the accident site. Once the alert is generated, the Responding System (RS), representing the first responder ICT systems, takes over by receiving the alert and managing the dispatch of rescue teams to the incident location. Meanwhile, the Curing System (CS) refers to ICT systems in hospitals and emergency rooms where the patient will be transferred, ensuring that critical vital data is communicated efficiently so the hospital can prepare for the patient's arrival.

At the core of the ISAN platform is the ISAN System, which coordinates the communication between all ICT systems. This System consists of the Workflow Manager (WFM), which oversees the sequence of actions ensuring that all rescue operations are carried out in the correct order, the Communication Manager (ComM), which handles the secure and reliable transmission of data, and specific System Managers for the alerting, responding, and curing systems to ensure the correct integration of each system within the platform.

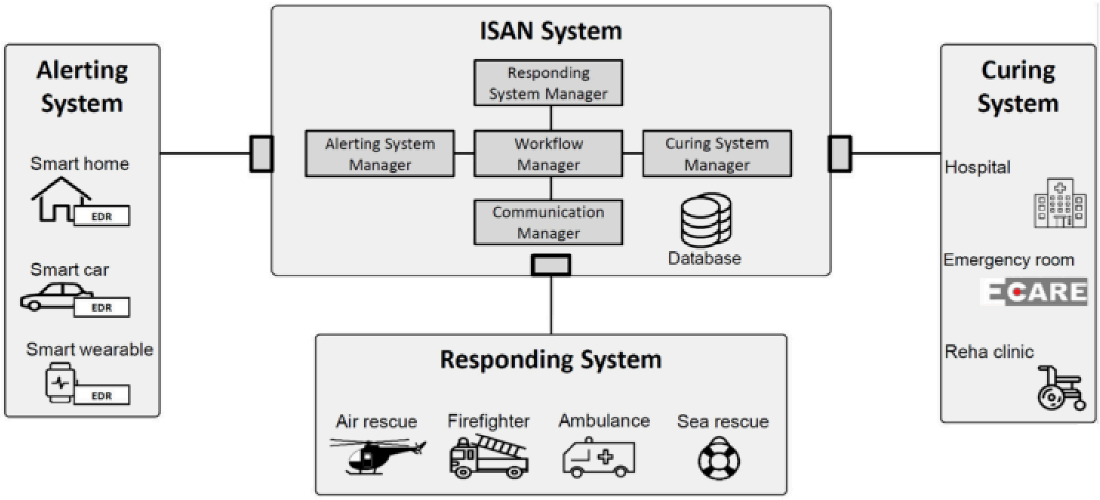


Fig 1: System architecture of the ISAN emergency communication platform. [1]

The ISAN project is already capable of performing advanced tasks such as the transmission of Electrocardiogram (ECG) data between the Alerting System and Curing System or visualizing emergency situations by displaying both the location of the incident and the hospital to which the patient will be transferred on a map (Fig 2). To further enhance the capabilities of this platform, this thesis focuses on the integration of Rescuetrack, specifically aiming to include the real-time locations of emergency vehicles into the map, enabling more dynamic and accurate coordination of rescue efforts.

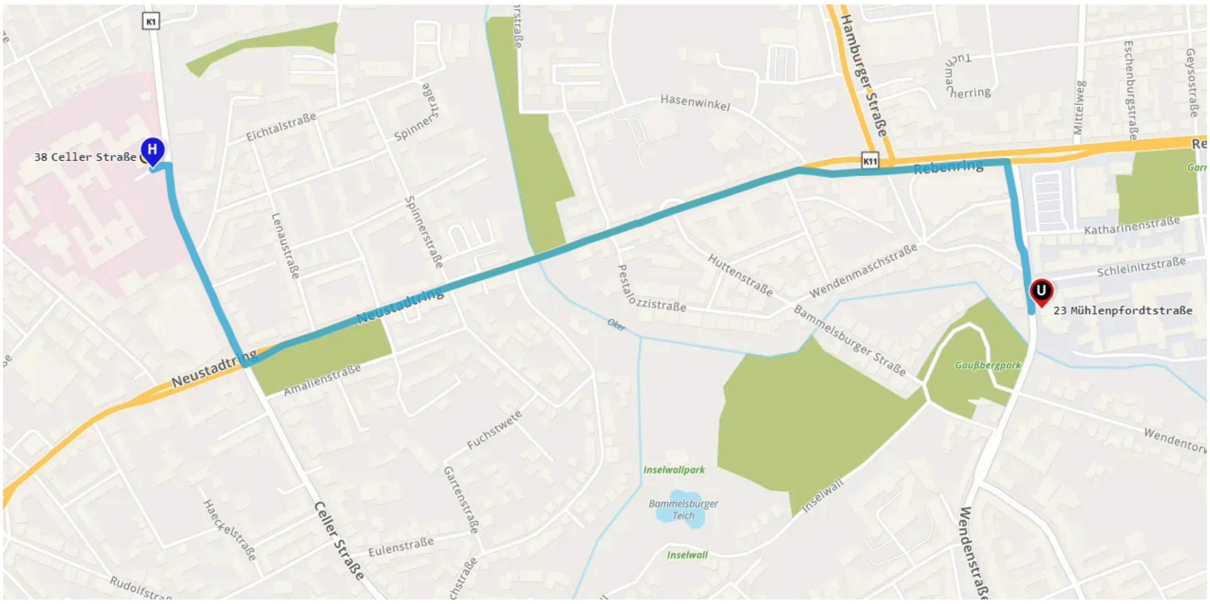


Fig 2: The displayed map in the curing system after alarm generation (U) and hospital (H) assignment. [1]

2 Motivation

One of the motivations for this integration is the ability to provide real time visibility of all emergency vehicles, which is useful in complex scenarios, such as multiple accidents occurring in the same or close area, where coordination between different rescue teams is crucial. In these situations, having a visual depiction of the incidents' geography area for each rescue team is essential, as it will be helpful to avoid overlapping and ensure that all incidents are managed efficiently and without delays.

Another motivation is that with the help of IoT and Car-to-Car (C2C) Communication, emergency vehicles can receive real-time traffic conditions, such as the presence of traffic jams or flooded roads. This will help to receive a second best route, corresponding to the vehicle's current location, on the map without the driver or someone else manually trying to think of an alternative. Similarly, in case of a vehicle breakdown or a situation where the initial ambulance is no longer available, the ISAN platform can then automatically assign the next best available emergency vehicle.

Additionally, by being notified about the emergency and knowing the ambulance's arrival time at the hospital, the medical team will be ready to prepare the necessary equipment and allocate staff required for the patient's condition, ensuring a faster and more effective response upon arrival.

In an emergency, every second counts and we can see from above that the integration of this Rescuetrack plays a role in reducing the delays of the rescue team reaching the patient, which means, that we will have more chances of saving people's lives, especially in serious conditions.

3 Task Description

1. Integration of Rescuetrack

   Retrieve real-time location data (e.g. latitude and longitude) of an ambulance through the Rescuetrack's Application Programming Interface (API).

2. Display Location Data On Map
   - Implement functionality to monitor the movement of the emergency vehicle on the map (Fig 2) with respect to the communication protocols of the ISAN platform.

3. Additional Dynamic Adjustments:
   - Display and update the routes and the estimated arrival time of the emergency vehicles on the map.

- Implement functionality that reroutes a new emergency vehicle to an incident if the initial vehicle experiences a breakdown or becomes otherwise unavailable.

4. Simulation Scenario:
   - Create simulation scenarios involving multiple emergency vehicles and incidents. This will include the functionality of monitoring various vehicles on the map simultaneously, rather than just a single vehicle.
   - The first scenario is a major car accident involving three vehicles, where an ambulance is assigned to each vehicle's driver, first responding to the accident site and then transporting them to the corresponding hospital.
   - The second scenario is a single car accident where the driver is initially assigned an ambulance. The ambulance becomes unavailable due to a breakdown, and the system automatically reroutes a second ambulance to the driver.
   - Ensure that the map dynamically updates the locations, shows the routes of all involved vehicles, and estimated arrival time providing an accurate representation of the emergency response.

4 Literature Survey

4.1 Literature collection

To get a better understanding of the theme of this bachelor thesis, we performed a literature search based on the Scopus [4] and PubMed [5] databases. We applied advanced search techniques using logical conjunction "AND" and "OR" to combine keywords.

- Scopus Search Query: TITLE-ABS-KEY(("Ambulance tracking" OR "Ambulance location monitoring" OR "Vehicle tracking") AND ("GPS" OR "Global Positioning System" OR "GIS" OR "Geographic Information System" OR "Geolocation") AND ("Real-time" OR "Live" OR "Continuous")) AND ("API" OR "Application Programming Interface")

- PubMed Search Query: ((Ambulance tracking[Title/Abstract]) OR (Ambulance location monitoring[Title/Abstract]) OR (Vehicle tracking[Title/Abstract])) AND ((GPS[Title/Abstract]) OR (Global Positioning System[Title/Abstract]) OR (GIS[Title/Abstract]) OR (Geographic Information System[Title/Abstract]) OR (Geolocation[Title/Abstract])) AND ((Real-time[Title/Abstract]) OR (Live[Title/Abstract]) OR (Continuous[Title/Abstract])) AND ((API[All Fields]) OR (Application Programming Interface[All Fields]))

From the query on Scopus, we obtained 27 documents from 2008 to 2024, but from Pubmed, we found only one document. On Scopus, we applied document type limitations to constraint results in “Conference paper” and “Articles”, which left us with 25 results. Further, we filtered the results by subject area focusing on “Computer Science”. After this step, we had 20 results left.

After basic filtering, we had 21 results. The single document found in Pubmed was also found in Scopus so we ended up again with 20 unique results. We then reviewed the abstracts and titles to identify relevant papers, narrowing the selection down to 11 results. In the last step, we read through the remaining results and kept 5 documents, which we will then summarize in the following section.

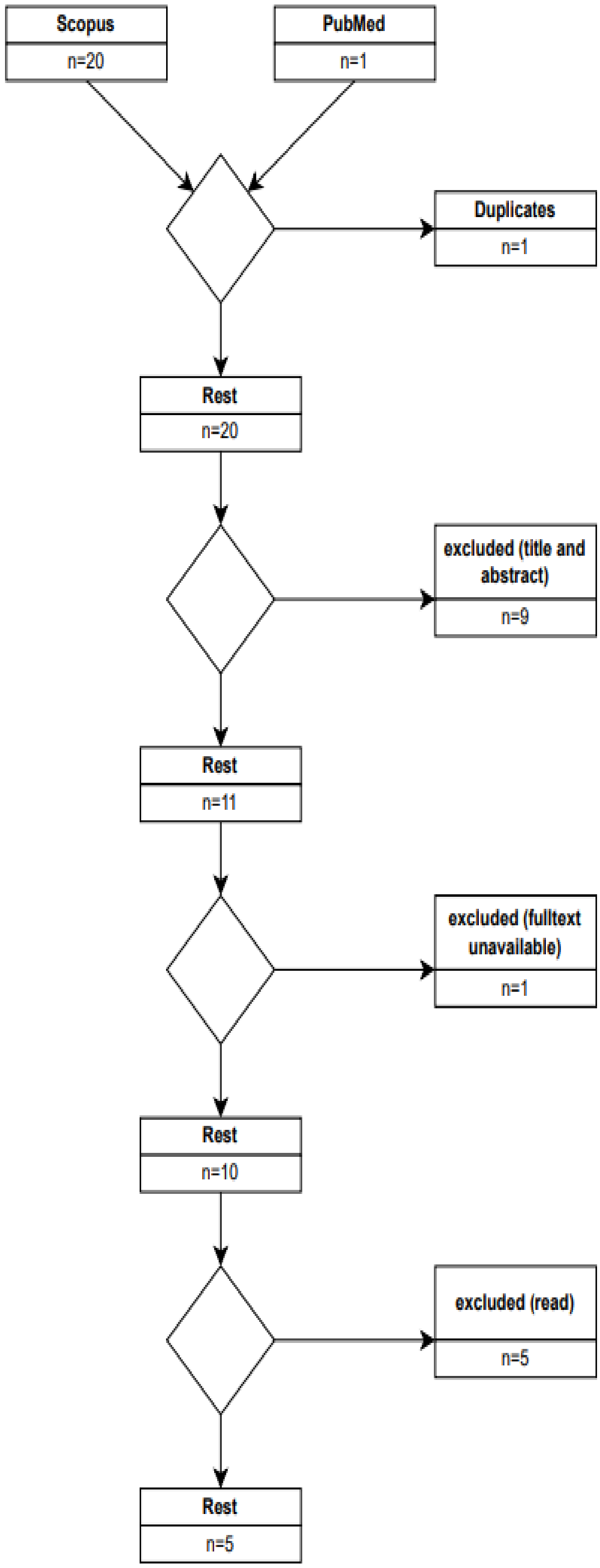


Fig 3: Flowchart of the literature search process

4.2 Literature summary

The selected papers present a variety of Global Positioning System (GPS) based vehicle tracking systems, each tailored to a different use case but sharing the common goal of real time tracking. Starting from similar contexts, Kim et al. developed an ambulance tracking system consisting of the Ambulance System, Control Maps Server, and Center Monitoring System [6]. GPS data from ambulances is transmitted to the Control Map Server, which processes and sends location updates to both the ambulance and the monitoring center using Google Maps API. The system utilizes GPS receivers in ambulances and GSM modules for data transmission. This gives medical staff the possibility to provide pre-hospital services to emergency patients based on the location of the ambulance. Polamreddy et al. designed an Android application to help traffic cops manage ambulance routes using GPS tracking [7]. On the hardware, the system consists of GPS modules, IoT models, and Arduino microcontrollers which will be installed in the ambulance. The application will be developed using Flutter, HyperText Markup Language (HTML), Cascading Style Sheets (CSS), and Javascript. It will generate a force alarm, which adjacent traffic cops will receive even if their smartphones are locked, notifying them in an emergency about the ambulance movements and the routes that the ambulance will take. This way, the traffic enforces will be able to clear the path or remove the traffic jam of these routes in advance. Rudramurthy et al. present a vehicle tracking system designed for smart cities [8]. This system is primarily used for tracking garbage collection vehicles and providing users updates on their location through the Google Maps API. In addition to tracking, the application allows users to report sanitation issues and view official news. To address the issue of vehicle theft, Shah presents a vehicle tracking system to transmit location data to a web portal, where the vehicle's location is displayed on Google Maps API [9]. It is built using Arduino and the SIM908 module, which combines GPS and General Packet Radio Service (GPRS) for both location tracking and data transmission. A notable feature is that the users can get on demand the current location of the vehicle by SMS without having to log in to the website in case of unavailability of the internet. Kim et al. developed a vehicle tracking application that aims to minimize the waiting times for public transportation by calculating the estimated time of arrival using Google's Distance Matrix API [10]. The system utilizes GPS and the Firebase real time database to continuously track buses and provide accurate arrival time predictions based on live traffic data.

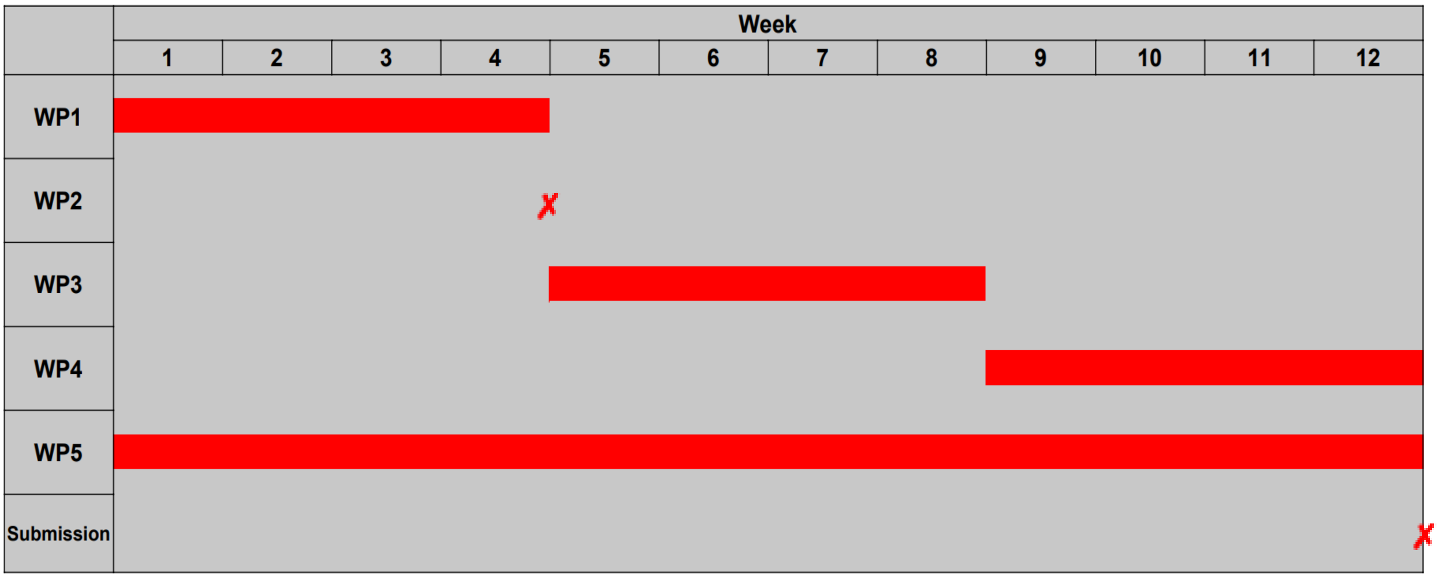
5 Research Questions

Based on the above, the research questions of this thesis are:

- How feasible is the integration of Rescuetrack into the ISAN platform?

- How well can the ISAN platform dynamically update emergency vehicle positions on the map?
- Can the ISAN platform feasibly display multiple emergency vehicles on the map as required by the simulation?
- Is it feasible for the ISAN platform to automatically reroute a new emergency vehicle in the event of a vehicle breakdown?
- How well can the ISAN platform update the routes and the estimated arrival times of emergency vehicles?

6 Time Plan



6.1 Work Packages

6.1.1 WP1: Rescuetrack Integration And Monitoring Setup

This phase aims to integrate the Rescuetrack API into the ISAN platform. The necessary logic for retrieving real time location data from the Rescuetrack and displaying it on the map, which includes setting up the logic for continuous data transmission and updates with respect to ISAN communications protocol, will be implemented so that the emergency vehicle locations can be shown and dynamically updated on the map.

6.1.2 WP2: Driving Test

The purpose of this phase is to test the tracking performance using live data from the Rescuetrack API under actual operational conditions to ensure correct integration of the Rescruetrack.

6.1.3 WP3: Implementation of Additional Dynamic Adjustments

This phase aims to implement the functionality that reroutes a new emergency vehicle to an incident if the initial vehicle experiences a breakdown or becomes otherwise unavailable in addition to displaying and updating the routes and the estimated arrival time of the emergency vehicles on the map.

6.1.4 WP4: Simulation and Validation

This phase aims to create simulation scenarios with multiple incidents and emergency vehicles. This will include upgrading the single-vehicle monitoring functionality implemented in WP1 to enable the simultaneous monitoring of multiple vehicles on the map. A CSV file can be used to simulate the real time transmission of vehicle positions. This phase allows the testing and refinement of both the functionality of monitoring multiple vehicles and the additional dynamic functionalities of WP3.

6.1.5 WP5: Documentation and Reporting

The final phase involves documenting the entire project and the completion of the Bachelor thesis. The report will include methodologies, solutions implemented, challenges encountered, outcomes of the tests, and answers to the research questions which will provide a basis for future work.

References

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