

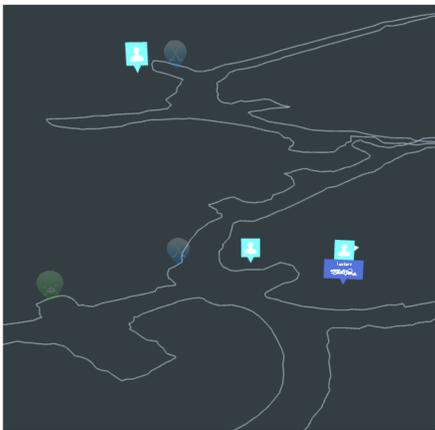
# Positioning in Underground Mines

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## Description:

This project concerns localization in mines co-habited with humans and machines using different radio technologies. The research targets both autonomous driving and safety aspects. Collaborations with Ericsson for 5G technologies and Cisco for next generation WiFi products serve as drivers for research. There is a rich literature on sensor networks, with generic scenarios with agents (moving) and anchors (stationary), while we here have a unique application that fits the standard models, but adds all aspects of a real application, which is believed to lead to a revised set of research questions.

## Background & Motivation



Localization of vehicles, personnel and other assets is an enabler for autonomy. Today, Boliden uses proprietary software based on WiFi access points provided by a third party. The accuracy is quite rough, with errors of a hundred meters not uncommon. While helpful, improvements are needed to enable safety critical applications.

## Research Goal & Questions

The primary goal is to improve the precision of underground mine positioning systems.

Some initial questions:

- What properties of the underground mine environment affect localization efforts, and how can we use them to our advantage?
- What data sources are present in the mine that we can use to improve accuracy with existing infrastructure?
- How could additional data sources, such as IMU's or LiDAR's, be used to further improve localization?

## Methods & Preliminary Results

As an initial step, a few different available methods are being tested to see which can provide reliable and useful data, all of which are dependent on sensor fusion techniques to combine data from multiple sources:

- RSSI indications from in-place WiFi infrastructure
- AoA extension of current WiFi equipment
- UWB ranging using new fixed infrastructure

The project aims to make maximal use of the access to real world mines for data collection and testing. Out of the above, UWB ranging (in collaboration with Ericsson), has so far made it to in-mine testing, and initial results suggest longitudinal precision in the order of one meter.

## Roadmap & Milestones

- Investigate properties of the mine environment, and determine a suitable signal propagation model
- Apply sensor fusion techniques and knowledge of mine topology to produce improved accuracy using existing hardware
- Introduce additional sources, such as IMU's, to push past boundaries of the current system
- Implement promising techniques into the live positioning system of the producing mine

Positioning using map information and UWB ranging in collaboration with Ericsson. Blue circles indicate range estimate to target (red).

