REFERENCE

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# Safety critical train positioning over multichannel commercial LTEs

## Finrail: Train Location at the Right Location

Trains do not drive around based on the whims of their drivers. They are centrally controlled in a similar way as an airport control tower directs the planes around an airport. Segments of the track are reserved for specific trains and the trains are then cleared to proceed to those parts of tracks. All of this is done, so that we would never have two trains trying to be at the same part of the track at the same time. This kind of a collision would lead to extremely tragic results. Due to the systems enabling this practice, train collisions are extremely rare events and most accidents on the railways these days relate to trains colliding with crossing traffic that is not centrally controlled such as cars and pedestrians.

What makes this all possible is a precise knowledge of the location of every train. With GPS in every phone (and multichannel router), you would think that this is easy, but the requirements for precision and reliability are on a different scale. The controllers need to know with certainty which one of the two parallel tracks the train is on, as the train is moving at a high speed and the difference between the tracks is on the order of a single meter. Further the reliability requirement extends to telecommunications in getting this information from the measurement point to the control center.

Traditionally, this has been achieved by making the tracks smart. Tracks have had sensors that can sense when a train is using them. This is a very reliable way of sensing the position, since we are not even interested in the train's position in relation to the landscape, but precisely in relation to the track segment. And the track is a stationary object, fully connected to the other segments physically. The downside is that building and maintaining such track with sufficiently dense chain of sensors is very expensive. And if the sensors are further apart, longer segments of the track need to be reserved for any given train, which means less of the maximum capacity of the railway can be used. Ultimately leading to fewer trains and fewer passengers.

## MOVING THE INTELLIGENCE FROM THE TRACK TO THE TRAIN

Finland has an impressive development program aiming of digitalizing the whole rail operation dubbed “Digirail”. As a key part of this effort, ongoing research and development is looking into moving the intelligence from the track to the train.

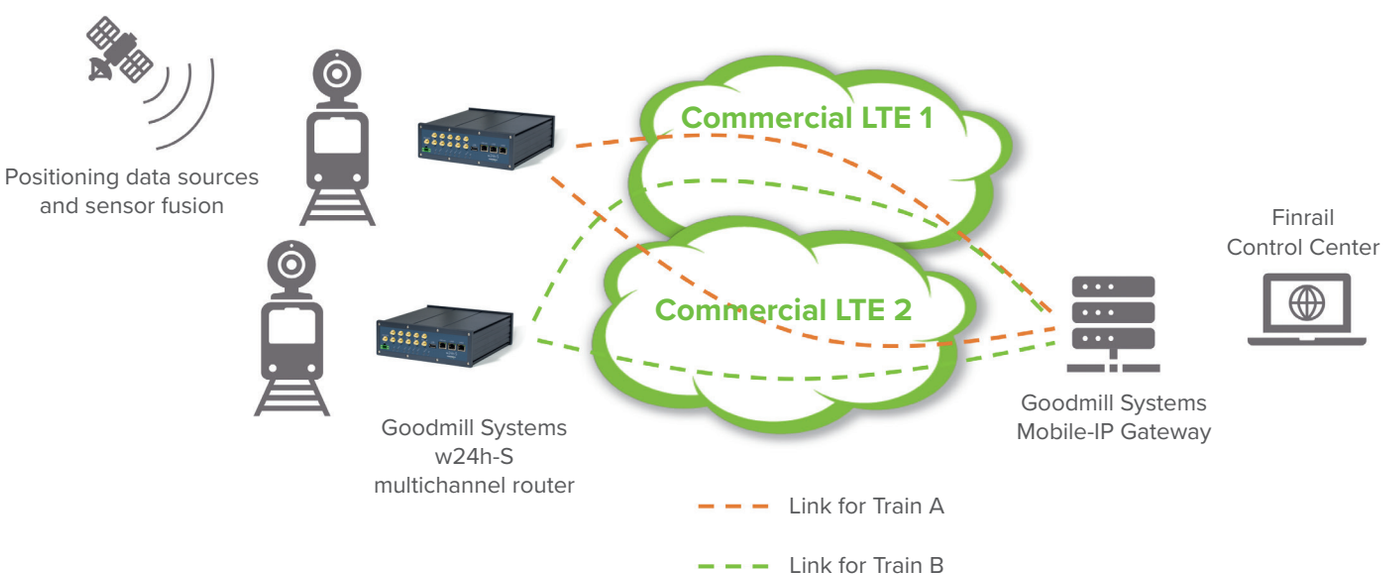
A month-long pilot on two train engines was executed in the spring of 2020 where a multi-redundant and sophisticated positioning system relying not only on satellite positioning, but also inertial and stereo camera -based systems was used to generate the location information and a Goodmill Systems w24h-S vehicle multichannel router with several commercial LTE networks was used to reliably transfer this information wirelessly from the train to the control center.

The challenge of this level of telecommunications on the railways may escape the layperson’s intuition. One should bear in mind that the environment is already physically challenging as trains move at higher speeds than cars, tracks tend to have more tunnels and higher obstacles closer to the track than highways. Secondly, while the networks used were logically independent, the onboard passengers with their individual devices and the passenger WiFi solution’s cellular backhaul present a massive peak load for the physical cellular radio access networks. In fact, in many parts of the track, the trains and their passengers may be almost the only users of the cellular network. Finally, railways are critical part of national infrastructure that need to operate even if, for example, satellite positioning systems and communication networks are being interfered with.

All these challenges were well suited to be solved with Goodmill, as our solutions are traditionally deployed in cases where precisely reliability is the main user requirement.

## THE TRACK AHEAD

The pilot was a success, and it achieved its results by meeting the reliability requirements even with just two LTE networks. Thus, Finrail could conclude that such a setup is a good solution in digitalizing the rail operations and we will continue to more extensive testing with a year-long pilot with additional positioning sensors and improved sensor fusion. The Digirail program continues as a frontrunner for the smart use of commercial digital technology on the railways and is on track to save billions of euros in costs as the current safety systems are to be replaced at the end of their lifetimes - not to mention the ability to safely drive more trains on the busiest sections of the track.

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