

# Sensor network for measuring ski vibrations

Degree programme : BSc in Electrical Engineering and Information Technology  
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Skitouring is one of the most popular sports in Switzerland, driving continuous innovation in order to reduce ski weight, hence enhancing climb ease and performance. This comes at the cost of vibrations, worsening ski-stability and comfort. In order to support manufacturers in the tradeoff between lightweightness and comfort, a sensor network for on-piste measurement of ski vibration is presented. Prototypes can then be extensively tested and compared prior to production.

## Relevance

Reducing the weight of skis improves their performance when travelling uphill, but increases vibrations during descent, which affects control and comfort, especially with touring and freeride skis. Although there are extensive vibration studies for alpine and on-piste skis, there is limited real-world data for backcountry use. This study aims to address this gap by enabling in-motion vibration analysis to support the targeted optimisation of materials and damping in lightweight ski constructions.

## Gateway

The gateway was designed for portability and intuitive handling in the field. Its core is also an nRF52840-based microcontroller board, ensuring seamless Bluetooth Low Energy (BLE) communication with the sensor nodes. An additional ESP32 module provides Wi-Fi access with the possibility to host a local web server for easy configuration and data access. All incoming data is saved to a SD card, allowing for straightforward retrieval and offline analysis after field testing.

## Sensor node

To ensure accurate and reliable data collection under real-world conditions, the sensor node was designed with a focus on low power consumption. A real-time operating system (RTOS) based on Zephyr handles efficient task scheduling and energy management. The module is built around a Nordic Semiconductor nRF52840 microcontroller with integrated BLE communication. Vibration data is continuously collected and wirelessly transmitted to the gateway. To protect the electronics during use in snow and moisture, the sensor is housed in a waterproof enclosure and securely mounted on the ski.

## Results

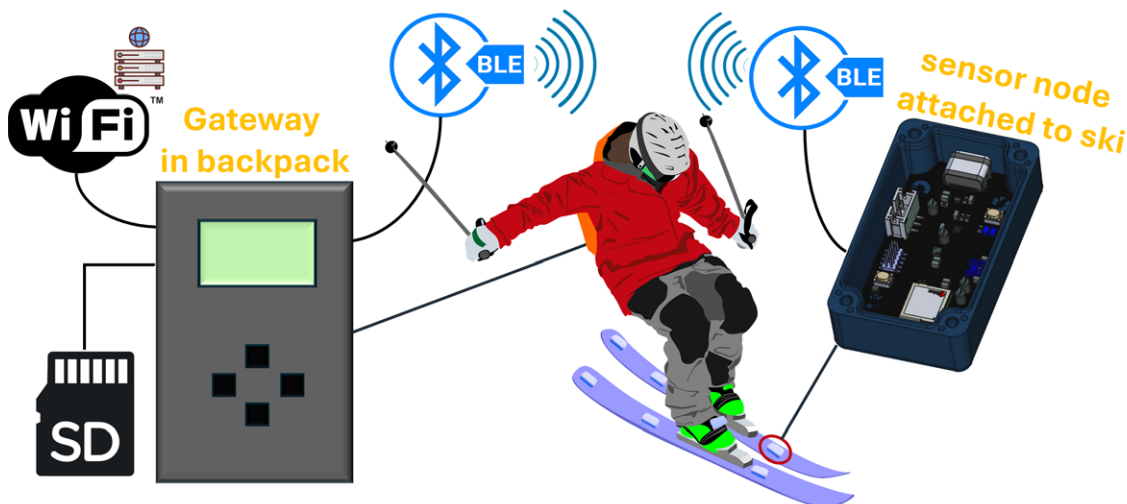
To evaluate the system, initial field tests were carried out directly on skis during piste runs. Although full functionality with all seven sensor nodes could not yet be achieved due to intermittent BLE connection issues, stable data transmission was successfully demonstrated with two nodes over a continuous period of approximately one minute. These promising results confirm the system's core functionality and provide a solid foundation for further refinement.



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Overview of the System