Title:	Monitoring vibrations during iron ore handling in Narvik harbour for LKAB
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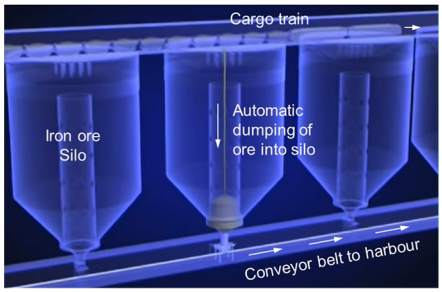
Main Objective:	Understand the relationship between iron ore handling and unwanted vibrations in the local area
Main Benefit:	Real-time feedback of the vibrations caused by handling operations, and high-quality data for possible root cause identification and mitigation

Background and description of the project

LKAB is transporting iron ore by railway to the novel SILA unloading station in Narvik harbour. The iron ore is unloaded from the train's self-emptying cars into gigantic underground silos and temporarily stored before it is funnelled onto underground conveyor belts and loaded on cargo ships in the harbour. The whole process is fully automated, but the operations sometimes cause unwanted transient vibrations in the local residential area.

High-frequency vibration monitoring with real-time feedback was important to better understand the relationship between unloading and generated vibrations.



Factors that influenced the design of the monitoring project

To understand the root cause and propagation of the transient vibrations, selected locations around the silos, underground conveyor belts and local area are monitored by means of high precision triaxial accelerometers. The total area spans several hundred meters, making it difficult to connect all sensors to the same network.

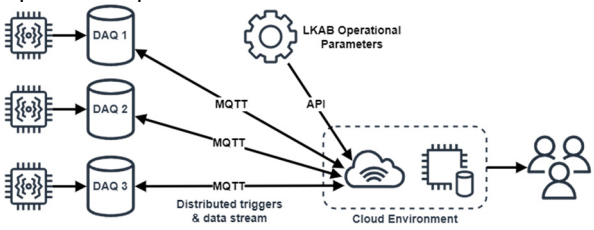
Key parameters and features required of the monitoring system:

- Signal statistics, such as maximum, RMS and characteristic frequency of the vibration speed
- Triggered and synchronized storage of high-frequency vibration speed transients for given thresholds
- Automation parameters from LKAB harbour operations

Scope of the instrumentation used

25 MEMS accelerometers were installed in four deep and one shallow borehole around silo 7, in the tunnel below and on a building north of the silo. The sensors were connected to three separate EtherCAT data acquisition systems, where two of the systems are mobile.

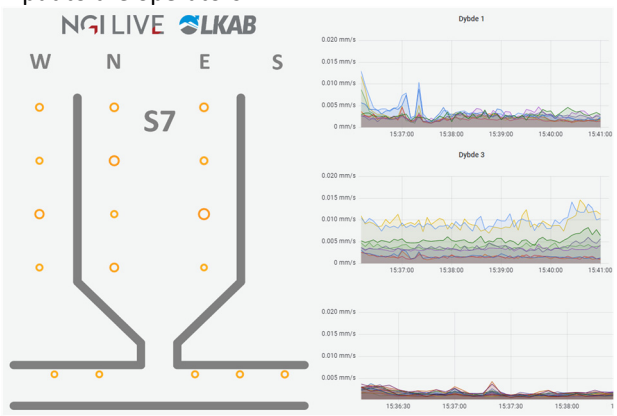
With three independent systems, a cloud environment is used to receive and visualize the accelerometer data in real-time, to distribute the trigger signals between the systems and to receive operational parameters from LKAB.



Example of data presentation

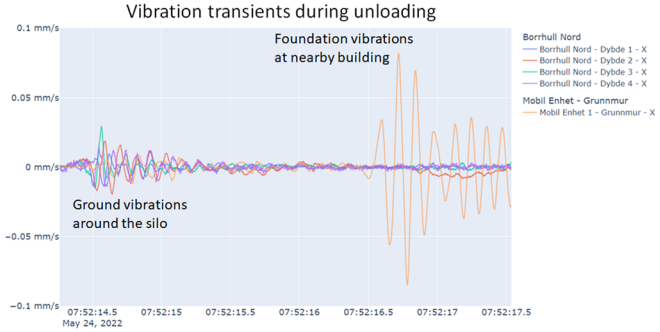
Multiple dashboards were created to provide the client with intuitive ways to monitor and interpret vibration parameters in relation to their operations in real-time.

The sample dashboard below visualizes vibration speed at sensor locations around silo 7 in real-time, providing valuable input to the operators.



Most significant information derived

From the vibration transients we can clearly see the vibrations propagating from silo 7 to the nearby building, while the vibrations also are amplified:



Using the operational parameters from LKAB, the transients can be correlated with unloading conditions and valve openings of the silos to better understand and avoid the conditions causing large vibrations.