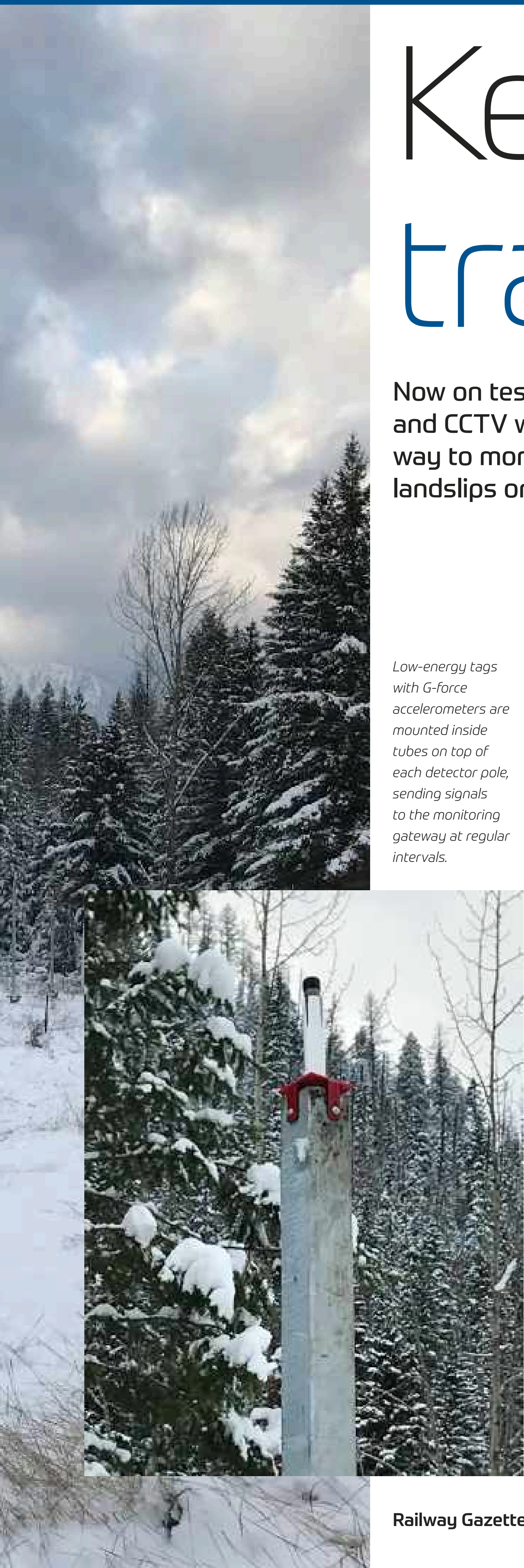
Keeping the tracks clear

Now on test in North America, a combination of mobile sensors and CCTV with advanced analytical tools offers an effective way to monitor remote sections of line at risk of avalanches, landslips or rockfalls



Low-energy tags with G-force accelerometers are mounted inside tubes on top of each detector pole, sending signals to the monitoring gateway at regular intervals.

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Avalanches, landslides and rockfalls have the potential to cause significant disruption to rail operations. Over the years, railways around the world have adopted various measures to protect their business and minimise the risk of a derailment, ranging from physical infrastructure such as snow sheds or retaining walls to wired slide fences and avalanche forecasting systems.

Most North American railroads that operate in high-risk areas use slide fences as a form of physical detection. Any avalanche or rockfall breaks detector wires strung between poles, alerting staff who can caution trains or close the railway pending a physical inspection. However, slide fences are not infallible, and they require a high level of maintenance. Cables can be broken through ice formation or the movement of wild animals, and they sometimes break of their own accord. This leads to false alarms, with emergency crews dispatched unnecessarily, while the routine maintenance of physical detectors over a large area can be very expensive.

More recently, several US Class I railroads have started to adopt digital technologies, primarily with a view to reducing the maintenance costs. One has been trialling a wireless detection system developed by L B Foster. Avalanche Total Track Monitoring sends alerts to operators about events in often remote locations that can lead to snow, trees and debris on the track. Proactive monitoring increases safety while minimising costs, and has already been shown to reduce delays to train services.

Integrated approach

L B Foster is best known as a supplier of track and friction management solutions, but following its acquisition of UK engineering specialist The TEW Group, the company has extended its capability into digital communications and remote condition monitoring. It is now working to integrate digital technologies with its traditional mechanical and electrical engineering to create smarter, data-driven products. These range from flood and bridge-strike warning systems using live data, CCTV images and email alerts to ways of streamlining maintenance cycles by monitoring fluid levels in trackside friction modifier dispensers, for example. Avalanche Total Track Monitoring is one such product, forming part of L B Foster's broader Total Track Monitoring range.

The system combines mobile sensor technology, CCTV and analytical software to create a stand-alone low-energy system that can be deployed in remote locations where fixed infrastructure may be unavailable. Long-life battery-powered RCM tilt and position sensors are attached to vertical posts at frequent intervals. When an avalanche or landslide knocks over one or more posts, this triggers an alert that is automatically relayed to the control centre. The small sensors are inexpensive enough to be deployed over hundreds of kilometres of susceptible routes.

Controllers are alerted when the integral G-force accelerometers are activated. The system is programmed so that the posts must go from being completely vertical to a 30° tilt within 1 sec. If only one sensor is knocked over it will trigger an alarm, but the system will not indicate an avalanche unless two or more sensors in the same area are knocked over.

Once the system has identified an avalanche, the operator must investigate to determine whether the track is passable. By their nature, such events typically happen in remote locations, where communications can be challenging and power is generally not available. L B Foster uses its self-powered Solar Gateway CCTV, which sends alerts and images via 3G mobile communications networks.

> ‘Proactive monitoring increases safety while minimising costs, and has already been shown to reduce delays to train services’

Testing, 1-2

The core wireless technology has been used for flood detection and embankment monitoring in the UK for several years. L B Foster has been able to use the same principles for detecting, and hopefully predicting, avalanche events.

Two test systems were trialled, one fixed to a slide fence and another placed in a snowfield with the potential for avalanches. This early experiment simply consisted of pushing the sensors into the snow. A relay box was set up with four tags on one system and three tags on another. The tags were G-force accelerometers, totally enclosed in a tube, which sent a signal to the gateway every 4 min. If the gateway detected that one of the tags had disappeared it would issue a warning to the dispatcher.

However, the fence-mounted equipment suddenly went into alarm mode in the spring, as the poles fell over when the snow melted. Wind also proved to be a problem, as poles moving around in the snow led to the triggering of false alarms. Every such alarm required maintenance crews to go out and investigate. The tags were therefore reprogrammed to respond to a specific movement from vertical to a 30° tilt in 1 sec.

Our Class I partner then pointed out that ‘if we can remotely access the system to see what the situation is on-site, to look at the tags and see their orientation, to see signal strength, to see whether the battery level is up and what the temperature is, we don’t have to send people into a potentially dangerous environment’. This led to the development and testing of a Mk II version.

This uses larger posts with a proper base and a shear pin to secure the post in position. Currently, tags can be located at up to 600 m from the gateway, but adjustments are being made to improve the wireless system. Tag orientation, signal strength, battery power and the current temperature are all displayed on a monitor.

The sensor algorithms were rewritten to eliminate the risk of an alarm being triggered by wind vibration. A ‘shock factor’ was added, which gives a velocity indication depending on the speed of impact on the sensor posts. The status check function has also been modified, delaying the triggering of a maintenance alarm to allow for any temporary radio loss or interference.

The Mk II version has been on test for more than six months, without any false alarms. The project partners believe that the system is now ‘ready to go’ from both the commercial and safety perspectives.

Predicting over a bigger area

Future developments will include the development of a repeater configuration, extending the scanning range from the current limit of around 600 m. The existing

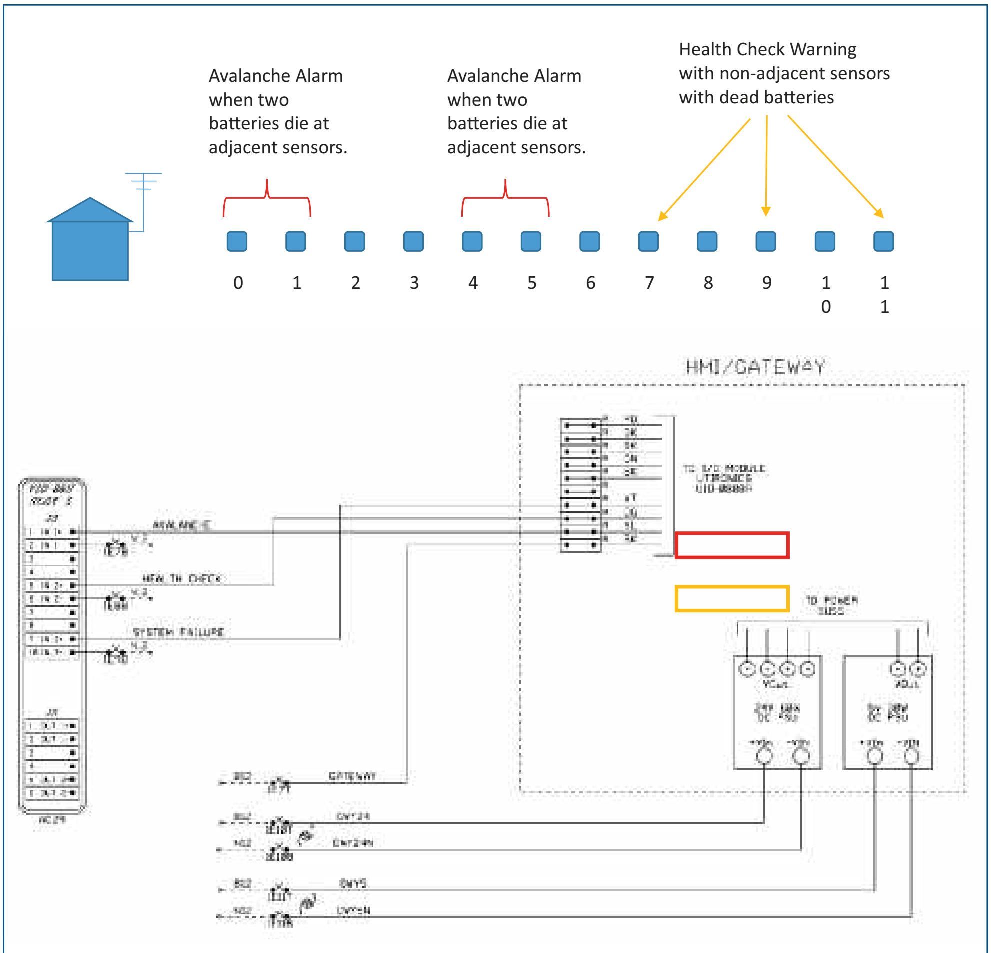

Fig 1. A health check function is built into the HMI monitoring gateway, allowing the system to differentiate between power failures and potential avalanches.

technology can handle three or four gateways, each carrying about 20 tags. Using a repeater principle would enable the deployment of many more tags, significantly extending the coverage area.

Currently, railways are not able to accurately predict future avalanche or landslide events, because the slide fences are reactive, not predictive. However, researchers are already working on ways to predict an avalanche before it happens. Each tag provides a temperature reading, and the team is logging that data in order to determine historic trends. In future, perhaps, it could be determined that a 5° rise in temperature over a 24 h to 48 h window, for example, was sufficient to raise the potential avalanche risk, triggering an appropriate alarm in the control centre.

Another example might be when an area experiences heavy rainfall, putting some embankment or cutting slopes under pressure. A sensor network could be deployed relatively quickly in the affected area to determine if a mudslide does happen, so that the railway could react appropriately.

Lidar rockfall monitors

Another test now underway with a Class I railroad in Montana is investigating the potential use of L B Foster's Insight LIDAR technology for rockfall detection.

As with avalanches, the traditional way of monitoring for rockfalls is to use wires stretched above the track that are broken when debris falls through them. However, this approach does not indicate whether the offending rock has ended up on the track or rolled off again. It also requires the deployment of repair crews to re-string the monitor wires each time they break.

Insight LIDAR has been used in the UK for obstacle detection at level crossings, and it is now being trialled to detect the presence of rocks on the track of sufficient size to pose a derailment threat. The remote sensing technology can be deployed along vulnerable sections of route, alerting controllers about the size and location of an obstruction, minimising the risk of a derailment. Although staff may have to be deployed to clear the track, the use of LIDAR would avoid the need to send out specialists to repair the detectors after any incident.

Each gateway can currently monitor up to 20 tags, spaced at broadly 10 m intervals. A typical installation with three or four gateways can monitor around 600 m.