Major US railway uses Nokia analytics to manage flood risks

Needing to better manage flood risk on over 50,000kms of railway lines, a major US railway approached Nokia to help it develop analytics software to better predict potential track washouts. The Nokia Water Events Prediction solution now helps them identify at-risk track sections, target assets requiring upgrades such as culverts and track beds, and notifies operational personnel in advance of track-affecting potential flood conditions.

Business benefits
- Better risk management and accurate capital planning
- Decreases the number of derailments and line disruptions for improved customer service
- Improves safety and reduces costs associated with clean-up operations, late delivery penalties and demurrage fees.
With the changing climate, larger and more frequent weather events were becoming normal and historic flood levels were being exceeded routinely.

Two kinds of events are typical with flooding, track bed washouts and derailments. It takes a mere 8cms of water on the track to derail a train. Besides the risk to human life and safety, the costs of these events run into the tens of millions of dollars when you add up damage to rolling stock and the track and bed repair costs. Service interruptions not only negatively affect the customer experience, but can result in late penalties for freight and, when delivering to waiting ships, demurrage fees.

The challenge was to better predict where and when floods might occur across the entire network. Historical analysis provided some useful data, but the vast majority of the company’s tracks had never experienced an extreme water event, so there was simply no data available.

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Solution

Nokia researchers worked closely with the customer and scientific partners to develop advanced hydrologic models for the terrain the company’s tracks traversed. Incorporating past water events, weather forecasts, ground elevations and other terrain characteristics resulted in an analytics model that could be used to predict water events and asset vulnerability.

The Nokia Water Events Prediction solution is based on Nokia’s advanced analytics platform, which can be used to build digitally based models for almost any asset-intensive industry. It uses machine learning to analyze historic and real-time streaming data to create actionable information on likely future outcomes.

In this case, Nokia developed predictive analytics to model how water will flow across the terrain crossed by the company’s track network. On a continually updating basis, real-time weather data is loaded and analytics are recalculated to produce probabilities where track locations are at risk of a flooding event. Where locations exceed defined probability thresholds alerts are generated and distributed to operational staff who investigate the local conditions to analyze the best course of action to mitigate risk to assets, environment and life. Being based on machine-learning analytics, the program also learns from how events actually unfold and its predictive accuracy improves over time.

Flood Science

Rainfall → Effective Rainfall → Soil surface

- Soil’s water capacity = $W_m$
- Soil saturation = $S_s$

Rainfall → Actual evapotranspiration = $C_{et}^{PET}$

- Variable infiltration curve = $b$
- Amount of water that infiltrates at a rate = $K_m$

Overland rainfall excess → Direct runoff

- Impervious area = $I_p$

Interflow rainfall excess → Interflow reservoir

- Kinematic wave model
- Subsurface flow (slow flow)

$Q = K S_i$
Data science uses advanced algorithms to identify at-risk track sections

- Capital planning: identifies locations with chronic flooding for infrastructure improvements
- Operational risk reduction: advances notification of potential high-water conditions
- Leverages advanced hydrologic model
- Incorporates past water events, weather forecasts, ground elevation and other factors into analytics result set
- Presents details in rich user interface
- Proactively sends email alerts and SMS messages to personnel

About Nokia

- Experience building mission-critical networks with 1000+ industrial customers globally
- More than 70 large corporate customers trust Nokia today
- Real-life experience in most industrial segments
- Rich analytics and application suite
- Powerful and growing ecosystem of industrial partners for devices and applications to deliver business outcomes
- Bell Labs innovations are the secret to our market-leading solutions
How Nokia’s predictive analytics changes the game for asset-intensive industries

Despite several decades of digital adoption, asset-intensive industries have had difficulty fully adapting digital technologies into their operations.

With the advent of Industry 4.0 technologies such as IoT sensors, machine learning and artificial intelligence, it is now possible to digitalize entire operations, creating a digital twin of almost any operational process. This digital model can be analyzed based on historical and real-time streaming data to create insights on how best to optimize routines and predict issues requiring maintenance, re-design and the use of different approaches.

The ability to predict the flow of water over terrain based on soil type, slope and rates and types of precipitation events is, in effect, to create a digital twin of the railway’s single largest asset: its rail network. The Nokia analytics platform can be adapted similarly to other physical processes. For example, our machine learning analytics applications can be applied to predict the probability that assets will fail further into the future and with greater accuracy and confidence than traditional conditions-based analytics.

The Nokia platform was built for a wireless world and emphasizes real-time applications with data streams from anywhere. It is optimized for geospatial and time-series data streams. With Nokia technology, even the most limited devices can perform powerful tasks, and machines and sensors can communicate directly with people in the field to create a “short loop” for action. The ability to use the immense computing power of our cloud-based systems to optimize operations is a game changer for railways and many other asset-intensive industries.
About Nokia

Nokia creates the technology to connect the world, developing and delivering the industry’s only end-to-end portfolio of network equipment, software, services and licensing that is available globally. Our customers include enterprises that use our network portfolio to increase productivity and enrich lives. Mainline and metro transit railways provide reliable, safe, on-time, journeys for millions of people and products every day, playing a critical role in our communities and our economies. With a transformed, digital railway, operators can deliver new and fully connected rail experiences. With a reliable, secure communications network and Internet of Things (IoT) technologies, railway operators benefit from new levels of ‘connectedness’ and automation, while reducing costs, improving efficiency and enhancing overall service. They also increase the vulnerability of railway operations to cyber-attack.

Protecting today’s rail infrastructure calls for more robust communications network security with new technological and process measures. Nokia builds cyber-defenses aligned with a network’s operational objectives to achieve layered security across network, application, data, identity and access management, establishing a series of defenses that close off any attempts to exploit security gaps. Nokia’s end-to-end approach provides the protection that railways and their passengers deserve.

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