Getting the edge on fleet maintenance

Luke Smith and Alyssa Wedler explain how edge and cloud computing can transform mine maintenance practices

Luke Smith & Alyssa Wedler | 13 Jul 2017 | 10:00 | Feature |

Maintenance departments face a number of broad and extensive challenges on a mine site, ranging from parts and labour cost reduction initiatives, to battles for equipment availability with other mining departments. Managing maintenance plans when a high level of unplanned maintenance is already occurring (it is not uncommon for mine sites to perform 60% of maintenance in an unplanned manner) is another challenge.

Maintenance teams are often tasked with minimising repeat failures, but are unable to resolve the root cause without extensive manual analysis of previous failures. Today's advancing technologies, however, can help mitigate many of these issues.

Technologies for maintenance

Technological advancements are sweeping the globe, and mines everywhere are relying more and more on these advancements to closely monitor the health of their equipment components in real time. Many maintenance systems use the same Internet of Things (IoT) that connects various aspects of consumers' lives to also connect and monitor the different equipment units at mine sites, gathering data on each unit and compiling it in one central location. Every day, IoT is empowering mines to adopt a more connected, more controlled and more intelligent environment.

Intelligent maintenance management solutions are designed to collect and manage the overwhelming amounts of big data that mining equipment generates. Some systems can collect continuous data streams from every component on every piece of equipment, at one site or across many. But while the amount of data we can collect is undoubtedly impressive, big data has created a separate complexity around the management and analysis of that massive database.

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With all that data, where do you even begin to start your analyses? More and more, it's becoming apparent that collecting the right data at the right time is necessary to analyse these datasets in a way that quickly identifies results-driven actions.

Acquiring telemetry data from your assets related to the engine, chassis, drive system, tyres, and even related oil analysis, in real time, arms maintenance teams with plenty of raw and summary-style information to evaluate component health. From there, they can project the component's estimated remaining useful life, or even take immediate action (repair or replace) to mitigate a catastrophic failure.

When it comes to the health of equipment components, maintenance departments must identify:

- The failing component;
- The root cause of the component's failure;
- Component health degradation for the failure type (is the failure detectable earlier on the P-F curve?); and
- Actions to take to prevent future failures, or a plan to replace the component before it fails.

An intelligent maintenance management system provides plenty of data to confidently identify the above, and some of the recently-released systems can often process this data by two different technological means: edge computing and cloud computing. When utilised the right way, both of these computing means will help increase equipment availability, minimise troubleshooting efforts, mitigate catastrophic failures and provide analyses to identify component health degradation and predict when potential failure points will occur.

Edge computing

Edge computing, which is best for processing real-time data information streams, occurs at the equipment level to reduce latency and process algorithms locally without the need for high-speed internet. This serves as a mechanism to quickly notify operators and maintenance teams about critical, time-sensitive conditions while also enabling rapid data transmission for central processing.

The logic that would otherwise require time to send data to the cloud, run analysis, and push notifications back to an operator can now live in the equipment's on-board mobile system, essentially learning from big data analytics, and immediately feeding this logic back to the edge to prioritise critical issues and accelerate proper actions where and when they're needed.

Edge computing devices can send the data you need now (the 'right' data) as a higher priority to better prevent catastrophic failures, while still collecting and transmitting the rest of the data (the big data, not required now) in the background for longer-term processing and analysis.

For example, if a haul truck's engine oil levels are critically low, a maintenance technician will receive immediate notification. This real-time information drives technician action to stop the unit and address lubrication levels before major engine damage occurs. While intervening to avoid this catastrophic failure will deliver direct and often significant component cost savings, other indirect yet substantial cost savings can also be realised, including:

- A reduction in required personnel and material resources, since it takes far less labour time to address the lubrication levels than it does to replace major engine components;
- Potential avoidance of interruptions to operations, as a down truck may block route access if it fails in a critical path area of the mine;
- Avoidance of interruption to planned work, since units with planned maintenance now fall to a lower priority or delay, increasing their potential for failure; and
- A reduction in technician hazard risks and associated liabilities, as remote analysis reduces on-premises, physical analysis of components.

For example, an Australian coal mine utilised edge computing to prioritise the elimination of component defects, rather than reactively repairing components as they failed, improving its equipment and associated components' overall mean time between failure (MTBF) by 150% in one year. This translates directly to a decrease in unscheduled downtime and significant cost savings.

Intelligent edge computing solutions provide not only the mechanism for data collection and communication, but also the ability to process data quickly and display critical equipment information within milliseconds. By providing technicians with the time-sensitive information they need to reduce catastrophic failures through real-time actions, edge computing can help mine sites reduce safety risks through advanced analytics, minimise downtime via remote diagnostics, and reduce labour disruptions by ensuring the correct resource attends the correct jobs, with the correct tools and parts.

Cloud computing

Since big data generally requires some amount of analysis, an 'all data, all the time' capability is less suited for edge computing than it is for cloud computing; the big data priority focuses more on analysis than it does immediate message transmission. Furthermore, streaming large volumes of data requires massive storage and advanced analytics capabilities, unfavourable to edge computing.

In addition to edge computing, some maintenance management systems employ cloud computing to manage the large quantities of real-time and batch data that could have any influence over a component's health, spanning as many different informational points as possible.

While cloud computing may imply a higher latency than edge computing, its scalable mass collection and data storage facilitates long-term analysis. This enables mines to improve their maintenance plan by reviewing predictions of a component's remaining life, and provides a feedback loop to the edge configuration as new trends are discovered or old trends are disproved. The cloud's vast resource capabilities process heavier computing algorithms to predict potential issues related to component health, helping to improve root cause analysis of component failures.

While big data management is not a new concept, mining companies have only recently started focusing on the information and required actions behind the data they collect. The more data we can collect, and the more we can learn about how components operate and fail, the more opportunity to replace components based on their condition, rather than a fixed interval such as engine hours.

Many maintenance teams will replace components even though they are still in healthy condition and could have run for many more hours simply because the planned maintenance schedule dictates their replacement. While OEM guidelines specify replacement at certain intervals, actual operating conditions can often extend equipment lifetime well beyond those specifications.

One company proved this when it ran an engine until its condition required replacement, rather than replacing it at the OEM-specified 18,000 hours. The company monitored critical parameters such as blow-by pressure to ensure optimum engine life extension without running the component to failure, and extended the engine life by an additional 22,000 hours.

Cloud computing's massive storage capability also facilitates easier machine learning and analytics. Gone are the days that require an engineer to sift through huge raw data files; cloud computing feeds large datasets into intensive machine-learning algorithms that can identify trends, calculate predictions about component failures, identify components that are operating differently to other components with similar operating hours, and much more.

In the end, these complex algorithms and constantly-evolving data models provide maintenance departments with trusted information about component health, facilitating more planned maintenance instead of costly unplanned efforts.

An example of this comes from a large mine in Australia which reduced its unplanned events by about 25% in roughly a year's time after implementing an intelligent maintenance management system that utilises these complex algorithms. Considering that unplanned maintenance is typically three to 10 times more costly than planned maintenance, the shift to a more planned schedule saved the mine significantly in equipment downtime, as well as in component and labour costs.

Edge computing and cloud computing technologies process data differently, but they still facilitate the same outcomes: reduce safety risks, minimise resource and component costs, and shift maintenance activities to a more planned structure to minimise equipment break-downs.

Many maintenance organisations are unaware that solutions exist today that pair the immediacy of edge computing to prevent catastrophic failures before they occur, with the analytics capability of cloud computing to store, analyse, and ultimately improve their ability to predict and prevent future recurrence. This combined capability is a key part of a reliability-centred maintenance strategy that maximises machine performance.

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