



*Cloudy skies ahead. More and more miners are migrating their data transfer and processing to the cloud*

*Photo: Anglo American*

# Miners take their businesses to the cloud

With cloud computing, even the smallest mining companies can think big and get big results. Carly Leonida explores the benefits

**"D**ata in the mining industry has become so important that it could potentially qualify as a strategic asset in the near future." As a solution architect, one who was sponsored just last year by Facebook to study deep learning, Christopher Simusokwe, manager for data and collaboration at Australian gold producer, Evolution Mining, understands the value of data all too well.

"Data transfer, storage and processing can be a means to realising a mining company's business benefits,

such as improved mineral recoveries or finding the next game changing ore deposit," he explains. "However, data access is always a challenge, because it can reside in disparate systems such as process control systems or fleet management systems. Therefore, it needs to be transferred to a central storage platform that can handle varying volumes of data coming in at different velocities, for further processing and orchestration; that gives a mining company much needed insights for better decision making."

For miners, and many other enterprises globally, that platform comes in the form of a cloud.

The term 'cloud computing' refers to the practice of using a network of remote servers accessible over the internet to store, manage and process data, rather than a local server or a personal computer. Cloud computing is most commonly used to deliver tools and services such as databases, networking, software, analytics and intelligence on demand to clients who need flexible resources and economies of scale. ►

► The back-end of each platform or 'cloud' (including hardware) is managed by a vendor, eliminating the need for extensive and expensive equipment on site, and meaning that even the smallest company can access the tools used by the very largest players at a reasonable price.

A good example of how cloud computing is used in the wider world can be seen in Spotify – the company uses Google Cloud Storage to host music remotely. Users pay a small amount each month to access millions of tracks and albums on demand. Their front rooms aren't full of CDs/records, and their limitless catalogues, which can never get lost or scratched, are accessible anywhere, anytime, as long as users have connectivity. Everyone's a winner.

Now let's take that analogy and apply it to mining.

As mining companies advance towards the fourth industrial revolution and start exploiting technologies like the Internet of Things (IoT) and automation, the quantity of data

that they are generating has increased significantly.

Some of the biggest players that are fully kitted out with sensor technology can generate hundreds of gigabytes of data per day and it's not economical, nor necessary, to invest in the infrastructure needed to store it; especially when we consider that data volumes are set to rocket over the next few years.

Cloud computing offers the ability to rent this infrastructure and means that mining companies can access enterprise-grade, secure storage on-demand without having to maintain it or make big up-front capital investments. Major cloud platforms such as Microsoft's Azure, Amazon Web Services (AWS), IBM Cloud, Alibaba and Google Cloud Storage are scaleable and can easily accommodate the avalanche of data expected, enabling businesses to connect additional sensors to the cloud through software-defined gateways.

For communications specialist Inmarsat, cloud computing is an

integral part of the company's end-to-end managed IoT service.

Joe Carr, director of mining at Inmarsat Enterprise, explains: "With IoT solutions set to transform the mining sector through increased levels of automation and remote asset management, the ability to have visibility over mission-critical data is crucial.

"Data collected on-site by sensors and other connected technologies needs to be analysed by staff in control centres to monitor parameters like levels in tailings dams and staff health and safety, but these control centres may be located hundreds or even thousands of miles away. Transferring the data to the cloud enables staff to analyse it wherever they are and, make it actionable."

### **BIG DATA, BIG BENEFITS?**

"The main advantage of cloud computing is flexible storage and compute," explains Dr Penny Stewart, MD at data science specialist PETRA DataScience. "Some cloud computing solutions also have optional tools to enable companies to more easily ►

*Moving workload storage to the cloud has been one of the main ways CIOs have been able to increase their organisation's agility*

*Photo: Anglo American*



- centralise, secure and version control their data for reporting, business improvement insights and advanced analytics.”

The process of transferring data from a mine site to cloud storage means that it is backed up on a continuous basis, and the risk can be further spread using backups in multiple virtual machines at very low cost. This is key for the mining sector as the volume of data being collected and archived is high; in the past mining companies have struggled to store historical data with the usual practice of ‘rolling up’ (aggregating and analysing data) being used, resulting in the loss of raw measured data and any inference that can be drawn from it.

“Processing data through cloud computing has the benefits of using high performance parallel computing allowing real-time data assimilation and analytics,” Chris Hallson, lead architect at IntelliSense.io tells MM. “The alternative is to keep the data on site in ‘data silos’, which means the processing always suffers from the local hardware’s processing capacity and, in addition, it is difficult to combine multiple data sets and draw inference from them. The result is that there are no connections between different operating disciplines - making it hard for both an operator and manager to understand the bigger picture and how actions will impact the future at all levels.”

UK-based IntelliSense.io developed brains.app, a real-time decision-making platform that harnesses artificial intelligence (AI) on the AWS cloud, to help asset and capital-intensive industries such as mining become more efficient and sustainable.

The brains.app uses a hybrid cloud model (local + cloud) for data storage, processing and closed loop deployment.

“We use the local environment to store limited period data sets, specifically the ones with low latency,” explains Hallson. “We then use the cloud to process large amounts of data and the local set up for critical aspects/processes and short-term decision making. This enables us to combine both upstream and downstream data resulting in improved predictions and future decision making.”

One example of this setup in action is through the application of brains.app to optimise a mine’s pro-

cessing circuit; the AI software takes information about material that is stockpiled or in the upstream circuit and informs downstream equipment such as the SAG mill to adjust operating parameters depending on the hardness of the ore. Similarly, brains.app can predict the optimal operating conditions for a thickener up to an hour before ore arrives at the machine.

IntelliSense.io announced the successful application of its Thickener Optimisation Application at a mine site in Chile, and Grinding Optimisation Application at a Kazakhstani mine in January.

“Working with Digital Catapult, we were given access to a significant amount of cloud computing resources on AWS. This compute power was a key benefit which allowed us to speed up development and train larger models on huge data sets,” says Hallson.

At an enterprise level, moving workload storage to the cloud has been one of the main ways CIOs have been able to increase their organisation’s agility, accelerate their ability to innovate, strengthen their security and reduce their cost.

Jeff Walsh, senior manager for solutions architecture – mining and resources at AWS, explains: “Enterprises can be more agile as they can scale resources up or down at any time and add new services in an instant. Innovation is accelerated by eliminating data silos and giving customers the ability to extract value from their data by using machine learning and performing large-scale analytics.

“Security is strengthened as companies gain far more telemetry on their data when silos are erased, encryption controls are more advanced, and they inherit all of the controls, tools and certifications designed for even the most security-conscious organisations.

“Finally, cloud storage enables enterprises to reduce costs as they move to a more flexible buying model and eliminates over-provisioning, refresh lifecycles and all the costs incurred maintaining your own storage infrastructure, like support and labour expense. Cloud storage is far superior to the on-premises model.”

There is a misconception that cloud computing doesn’t work for industries with operations in remote areas, such as mining. However, the

opposite is actually the case; with traditional approaches, miners are limited to collecting, processing and storing data on site because of connectivity limitations. With modern cloud, hybrid and edge capabilities, they can have the best of both worlds.

Walsh says: “Edge capabilities allow you to collect, process, cache and opportunistically sync data with the cloud. In a virtuous cycle, massive data sets are collected from site and asynchronously sent to the cloud where they can be turned into derivative products or used to train machine-learning models. These derivative products and machine-learning models can then be sent back to the site with edge capabilities and used in a completely disconnected manner.”

### APPLY CLOUD SELECTIVELY

From mine site to boardroom, the benefits cloud computing offers are enormous; but it’s worth remembering that blanket coverage isn’t always the answer. Miners can get better value for money if they pick and choose where they apply cloud solutions on an individual basis.

In principle, cloud computing means that companies only pay for storage and computational power as they need it. However, in practice, they can end up storing data that will never actually be used, or at frequencies or resolutions that aren’t required for practical applications.

Stewart tells MM: “To moderate cloud storage costs we are seeing some companies sample their site-generated data down to frequencies and resolutions that are practically useful, rather than uploading everything to cloud. This is because mining companies are already paying for site-based data storage systems, such as PI historian, fleet management systems and geological databases, and also for OEMs to store their data.”

Carr agrees: “There are technically no limits on the amount of data that can be moved to the cloud, but mining companies should be questioning whether they really need to store, transfer and process all the data that they currently do. A non-selective approach to data collection and transfer can put real pressure on the network and is expensive, as well as overwhelming for staff trying to analyse it. When it comes to data, it’s about quality, not quantity.” ►

“It will be interesting to see how the roll out of 5G in mining markets affects the uptake of cloud services”



**Miners can choose to embrace cloud computing power and appreciate that it can give them an edge they never had before**

*Photo: Evolution Mining*

► Mining companies need to harness big data intelligently, collecting essential data points to help them to remotely monitor assets and enable predictive maintenance and fault resolution. For example, on a vehicle this could be engine temperatures, oil pressures or driver behaviour, to identify when failures will happen and which behaviours cause them.

“This doesn’t need lots of data, and, in fact, the volumes make little difference,” Carr adds. “It’s all in the variables, the exception and the analysis – you don’t need all the metrics and factors, just the smart ones.”

While cloud solutions are seen as flexible and on-demand, many cloud services have significant fixed costs for virtual machine processing. Additionally, some mine sites may not be able to support cloud applications requiring a high bandwidth, reliable internet connection; some sensors generate terabytes of data per hour, for example 3-D laser mapping and

hyperspectral scanners. If this data is required for near real-time applications, then it makes more sense to run the application at ‘the edge’ (on-site).

“Edge computing just means servers that are co-located with sensors and sources of data,” explains Stewart. “The advantage of edge servers is that data can be stored and processed on-site in real time without being affected by the internet reliability issues affecting many of the world’s mine sites.”

“Individual databases often work extremely well for specific applications across the mine value chain,” she says. “However, if a company wants to develop new applications that use data from multiple databases, they need to integrate the data from multiple applications and/or databases. While this is another application for cloud computing, just because data is stored in the cloud, it doesn’t mean it can be easily integrated into new applications.”

Integration requires either standardised data formats, or application programming interfaces (APIs). Some mining vendors (including PETRA) are working together with mining companies and vendors to develop APIs and standard data formats to enable applications to run across the whole value chain.

Stewart says: “Cloud computing facilitates the collaboration required to deploy our prediction and optimisation algorithms across the whole value chain. In addition to the hundreds of PETRA algorithms deployed by mining companies on their cloud platforms, we also deploy on vendor cloud platforms, including Weir’s award winning Synertrex predictive maintenance platform. And, we have partnered with Maptek, Resolution System and Akumen to deploy algorithms on their cloud platforms.”

Last year PETRA received thousands of dollars in AWS cloud credits following its win of the Komatsu Unearthed hackathon, and the ►

► company has also been admitted to AWS' Activate programme which provides low-cost cloud computing to start-ups.

Stewart explains: "Cloud computing is great for small businesses and start-ups because it provides highly elastic access to supercomputer processing. For example, our model-building compute requirements are extremely variable from day-to-day. Some days we are spinning up a couple of supercomputers each with 64GB of RAM. We use it for model feature engineering which is extremely RAM intensive. Accessing these cloud supercomputers only costs \$0.80/hour which is a very low cost option when you only need a few thousand hours a year."

PETRA has found that many miners are choosing Microsoft Azure solutions for their cloud computing, while most vendors use AWS, and the company has developed an API to bridge this gap.

"We have developed an API to directly transfer data from Azure to AWS without the need to download the data and then upload to AWS,"

says Stewart. "This can save us quite a lot of download and upload time at the start of a project and enables us to quickly dive into our customer's data."

### CATCHING ON TO CLOUD

The use of cloud technology is undoubtedly growing across the mining industry.

"Our research indicates that 82% of mining companies are using cloud to some extent, and that within three years that figure will increase to 97% as they look to grapple with their data and applications," Carr says.

"With more mining companies moving to the cloud, reliable connectivity is more important than ever, as without it, basic tasks become impossible. Therefore, those able to reap the benefits from cloud are predictably those able to invest in other technologies which facilitate it.

"The majors are certainly leading the way in their ability to adopt new technologies, with smaller mining companies following their

lead once the success of the technology has been established. It seems that the adoption of cloud computing is following this pattern," Carr adds.

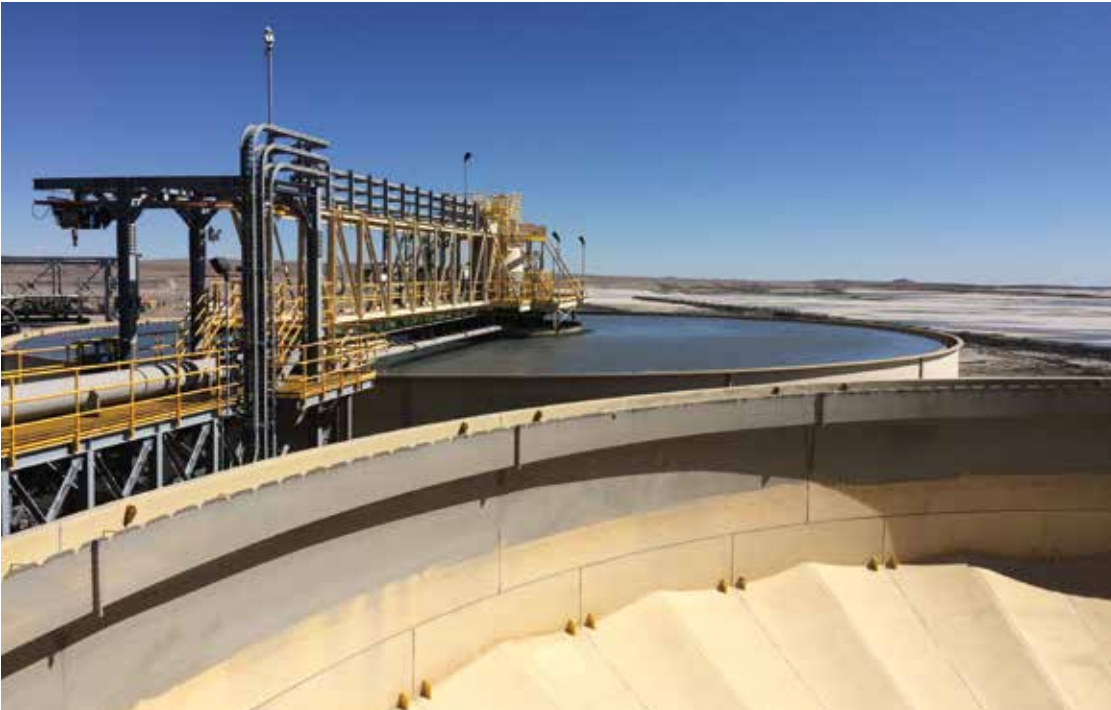
Stewart reports similar findings from PETRA's experience: "We are seeing both large and mid-tier mining companies adopting cloud computing for data storage, and some have invested heavily in developing custom built in-house data science platforms," she explains.

"Most METS [mining equipment technology services] companies that we know are either 100% on the cloud, have moved some of their applications to cloud, or at the very least have plans to move their applications over to cloud. Some of the reasons METS companies are moving to cloud include access to on-demand parallel supercomputing, and also access to the latest in cybersecurity protocols."

Evolution's Simusokwe explains this pattern: "Cloud computing is beginning to take off among major miners, with corporate offices usually located in markets where the likes of ►

*The processing plant at Evolution Mining's Cracow gold operation. The company is selective with its application of cloud computing*





*IntelliSense.io has successfully applied its Thickener Optimisation Application at a mine site in Chile*

- Microsoft, AWS or Google Cloud have locally based cloud data centres," he says.

"Major miners' interest in going for cloud computing could also be due to their geographically dispersed mining operations that may need to be managed from remote operation centres if they are to meet certain business goals. It's also because cloud computing has really experienced a step change in terms of its capability to handle and process real-time communications securely and reliably.

"However, junior miners can afford to go without cloud computing because they usually can locally operate their mine sites and their compute workloads might not be too much that on-premises server infrastructure can't handle it, notwithstanding that the cost of cloud compute might outweigh the benefits they might be chasing after all."

If the uptake of cloud computing is largely dependent upon connectivity, then it will be interesting to see how the roll out of 5G in mining markets affects its application. I would expect the two to go hand in hand; both are seen as key enablers of so-called 'Industry 4.0'.

Hallson at IntelliSense.io says: "Cloud computing is a key part of Industry 4.0. Individual processes are now able to become connected devices and act as independent decision-making agents through AI.

"However, there are still a lot of barriers to overcome with Industry 4.0; change management can be as substantial of a barrier as developing the technology. There is a huge opportunity though and this is constantly expanding as technology advances. That's why it's so exciting for us at IntelliSense.io to be working in this space with our customers, overcoming barriers together."

Like IntelliSense.io, AWS sees huge opportunity for cloud applications in operational technology at mine sites.

"As capabilities for cloud have evolved beyond the cloud and into the edge at remote sites, there has been an evolution of treating cloud as simply an IT play with cloud being embraced by the operational technology domains such as process control, metallurgical processing, fixed and mobile plant asset management, real-time planning and operations and health & safety," Walsh says. "In fact, we believe that operational technology is by far the largest opportunity space for cloud computing in mining."

#### DATA SECURITY

The major of cloud providers pour millions of dollars a year into ensuring that their platforms are as secure as they possibly can be and can offer infinitely higher levels of security than a mining company could achieve on its own.

However, as with any part of a network's infrastructure, user behaviour will always have a role to play in the security of a cloud platform and it needs to be configured correctly.

"Insecure passwords, shared login details, incorrectly applied settings and a multitude of other user errors can negatively impact the security of a cloud platform," Carr cautions.

"As the industry moves to integrate more digital technology into its infrastructure and generate more data that is stored in the cloud, it will require more staff that have the skills to securely manage and analyse this data.

"Without the staff who have experience in cybersecurity and data analytics, mining businesses will struggle to make best use of their data and keep it secure. It will therefore be critical for mining companies to work with partners who understand the importance of data security and build in multiple layers of security into the solutions that they provide."

Data transfer using cloud computing can be encrypted end-to-end, which increases security, and the data can also be divided into packages which need to be reassembled together with the encryption credentials to be able to be read by machine or person.

Hallson says: "Cloud servers typically have back-up power facilities to overcome any outages ►

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**"Inmarsat's research indicates that 82% of mining companies are using cloud to some extent"**

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► and the data can be stored on multiple servers, data centres and even across multiple physical locations.

“Security is an area we know is vital in the mining sector, having worked with the Kazakhstan government where geological data is a national asset – we ensure data is secured in all our operations whether they be on premises, cloud or a hybrid of the two.”

Stewart adds that cloud computing is considered easier to secure than on premise servers which in the past few years have the subject of ransomware attacks, some of which have made it into the media.

“You can pay for premium cloud servers that are located in countries perceived to be able to offer higher levels of security for cloud server locations,” she explains. “For example; PETRA pays a premium for Australian-based cloud servers.”

Walsh says that AWS has 203 significant compliance, governance and security certifications and is the only cloud provider to achieve a security level high enough to store TS/SCI data – the highest security rating in the industry since 2014.

“Companies gain far more control and visibility of their data when silos are broken down,” he explains. “Encryption controls are more advanced, and they inherit all of the controls, tools and certifications designed for even the most security-conscious organisations, such as banks or government agencies.”

#### WHAT'S AVAILABLE?

With so many platforms and tools on offer, it makes sense to look at what one of the market leaders, AWS, can provide as a benchmark.

The company now offers more than 165 fully featured cloud-based services, including: compute, storage, databases, networking, analytics, machine learning and AI, IoT, mobile, security, hybrid, virtual and augmented reality (VR and AR), media, and application development, deployment and management.

The AWS Cloud operates 60 Availability Zones within 20 geographic Regions, with 12 more zones and four more Regions in Bahrain, Hong Kong SAR, Italy and

South Africa coming online by the first half of 2020.

Walsh explains these terms: “AWS has the concept of a Region, which is a physical location around the world where we cluster data centres. We call each group of logical data centres an Availability Zone. Using AWS enables customers to deploy hundreds or even thousands of servers globally in minutes. This means they can very quickly develop and roll out new applications, and it means teams can experiment and innovate more quickly and frequently. If an experiment fails, you can always de-provision those resources without risk.”

Walsh also cites elasticity – the ability to scale resources to a business’ exact needs at any point in time – along with faster innovation and cost savings as key benefits of AWS.

“If you look at how people end up moving to the cloud, almost always the conversation starter ends up being cost,” he says. “AWS allows customers to trade capital expense for variable expense, and only pay for IT as they consume it.

“A good example of how cloud computing is used in the wider world can be seen in Spotify”




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And, the variable expense is much lower than what customers can do for themselves because of AWS' economies of scale."

AWS can store virtually any amount of data, and clients can transfer megabytes to exabytes of data to the cloud using clients' network links with scripts, AWS managed transfer services or Amazon Partner Network (APN) tools.

"AWS offers the broadest set of services and partner offerings for data transfer, hybrid cloud storage and edge computing – in addition to the broadest set of storage services," Walsh adds. "AWS has 11 different ways to get data into and out of the cloud depending on the nature of the data and application. Nobody else has more than half of that."

AWS and its APN partners offer capabilities for data transfer, hybrid storage and edge computing architectures. "Whether you have one terabyte or hundreds of petabytes to store, process or access from your data centre, branch office or disconnected field location, AWS has protocols and capabilities to meet your

IT operations team's needs," Walsh says. "For example, mining companies can use clusters of Snowball Edge Compute Optimized devices for serverless or Amazon EC2 instance-based edge computing workloads, including full-motion video, machine learning, embedded applications and IoT.

Additionally, for data centre or network-connected remote offices, AWS Storage Gateway provides hybrid storage capabilities that help customers get started with cloud by bridging on-premises environments to AWS.

AWS' mining clients include Canadian gold miner Banro Corp, which owns four properties along a major gold belt in the Democratic Republic of the Congo (DRC).

Banro uses Amazon Elastic Compute Cloud (Amazon EC2) as an offshore data centre solution, running eight full-time instances ranging from m1.small to m2.2xlarge.

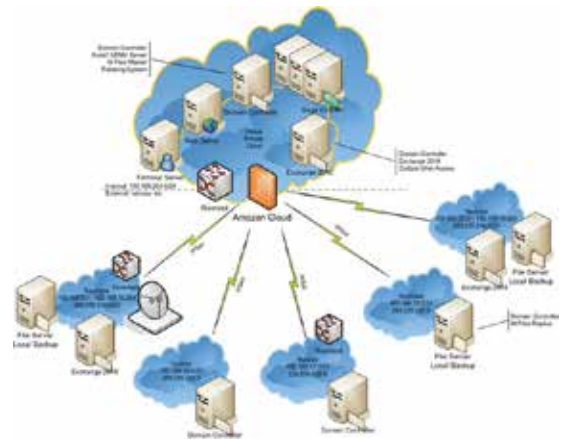
Another component of Banro's solution is a global distributed Active Directory, with two domain controllers in the cloud replicating to regional servers. This enables shared

identity, authentication and policies to be applied to Banro's five offices in Canada and the DRC.

Banro has also migrated its production Sage ERP X3 system to AWS in addition to its web-based workflow solution and central financial reporting data warehouse, and Amazon Simple Storage Service (Amazon S3) is used for offsite backups.

In the full case study, available on the AWS website, Thorsten ▶

Diagram showing Banro Corp's architecture on AWS



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► Neumann, Banro's group IT manager, commented: "We launched new systems into production within minutes instead of months or even weeks, and successfully avoided having to negotiate with data centres, provision rack space and procure the required hardware. We worked with Riverbed, which enabled us to connect our ERP directly to the cloud."

"Our first system, Microsoft Exchange 2010, was rolled out in about four weeks. The migration of our production Sage ERP X3 (and auxiliary components), along with creating the environment and user acceptance testing, took about eight weeks."

### FOLLOW THE LEADERS

It's always good to see how other miners are taking advantage of different solutions.

Simusokwe talks us through how Evolution Mining is benefitting from cloud computing.

"At Evolution Mining, we don't simply embrace cloud technologies just because everyone is doing it. We embrace it only where it makes business sense and is fit for purpose for us," he says. "We also have a good understanding of where it can work for us and where it can't, so we approach each user requirement on

a case-by-case basis, meeting some of the requirements on-premises and some in the cloud.

"In terms of digitisation, we recognise the role of cloud computing for the IoT, for big data processing and advanced analytics. We have designed a strong architecture that supports digitisation and initiates the secure exchange of data between our remote operations and our cloud infrastructure where we can process it at a larger scale to derive valuable business insights for informed decision making."

Evolution has chosen to predominantly invest in Microsoft Cloud-hosted technologies. "But that's not to say that we will never explore alternatives," Simusokwe adds. "Our approach from a cloud technology perspective is to look at what makes business sense for the organisation on a case-by-case basis and not standardisation. We look at what business requirements the envisaged solution should meet, and then work backwards to find fit-for-purpose cloud technologies that can meet our requirements in the most effective and efficient manner."

All areas of Evolution's business use some form of cloud computing, and some of the benefits that have been realised include improved

labour productivity and better business intelligence for decision-making purposes.

Simusokwe says: "Miners can choose to either continue using technologies the legacy way, without any cloud platforms, and they will potentially get the same operational results they have always got, since on-premises computing power can only process so much. Or they can choose to embrace cloud computing power and appreciate that it can give them an edge they never had before and, with the right cloud architecture, they could potentially get better operational results."

He sums up the current climate in mining rather well: "Operational continuous improvement is always of interest to any mining company. We all know that you can only get so many running hours in a shift out of equipment for example, and to take a business to the next level, it's no longer about the quantities you can chunk out, but the quality of what you process.

"You can't easily and accurately calculate or predict the optimal operating levels for equipment using on-premises computing power; you need to take advantage of cloud computing instead, and this is the point where machine learning and AI might come in too." ▼

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**"Cloud security controls are good enough for even the most security-conscious organisations"**

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*IntelliSense.io's brains.app is a real-time decision-making platform that harnesses artificial intelligence (AI) on the AWS cloud*