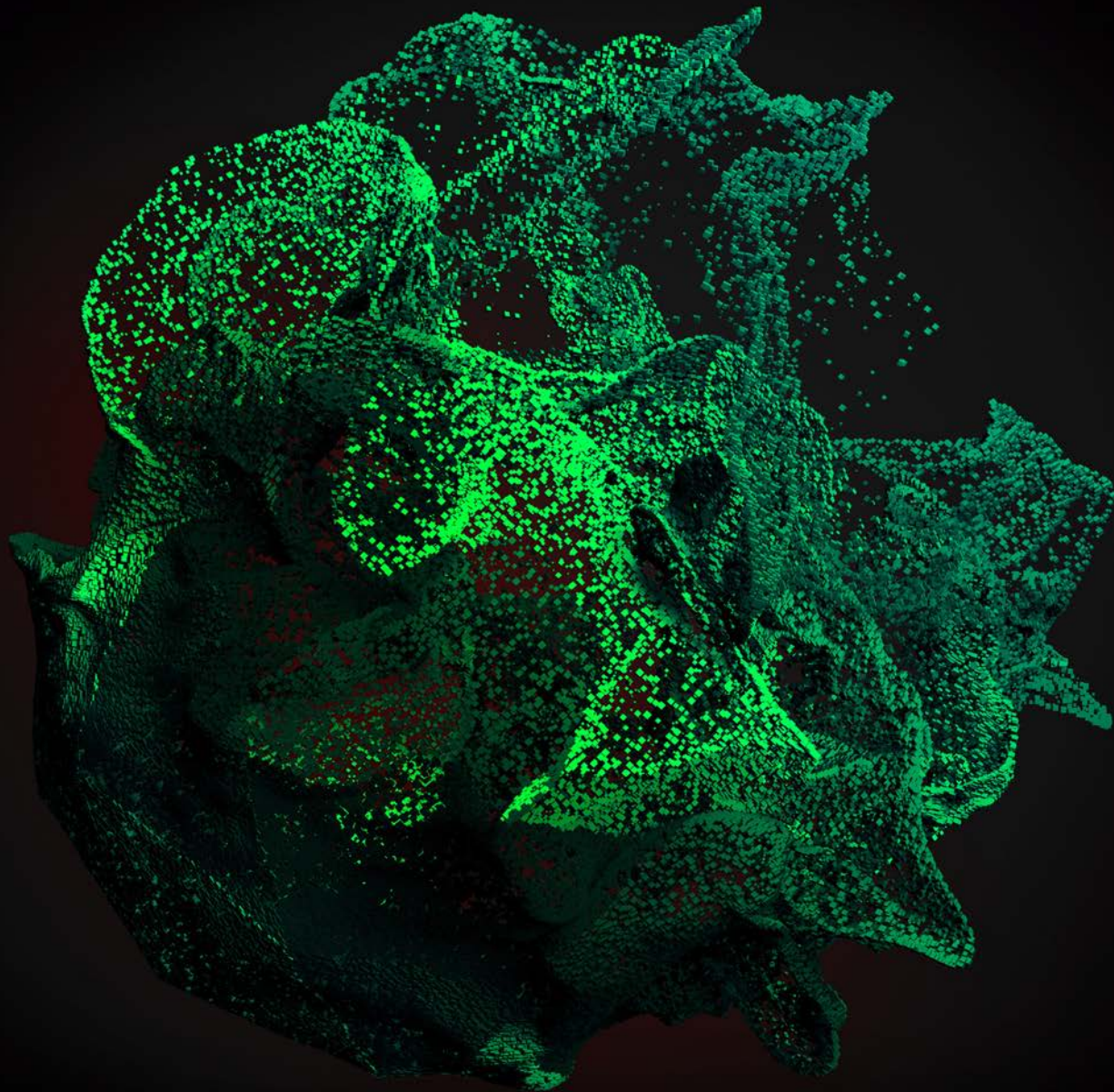


**Deloitte.**



**The digital revolution**

Mining starts to reinvent the future

February 2017

Success for mining companies is not about adopting the latest applications or technology solutions, these will continue to develop and evolve. They must instead embed digital thinking into the heart of their business strategy and practices in order to completely transform the way corporate decisions are made across the enterprise.

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# Introduction

The disruption of business models through the advancement of digital technology has been a reality for other industries for many years. Digital is now impacting the mining industry. Technology has advanced such that the barriers of high cost of entry, and a very physical value chain are no longer protection against large scale disruption.

By bringing together our understanding of shareholder value, mining operations, technology and analytics, we have developed an approach to the “digital mine” which helps mining organisations make the most of the digital opportunity and avoid the many potential pitfalls that come with the adoption of new technologies.

Our recent “Innovation in mining” studies examined current perspectives on mining innovation around the world.<sup>1</sup> Among the 31 mining companies involved in the Australian study, most agreed that successfully navigating the industry’s mounting challenges and ensuring the long-term sustainability of the sector requires moving beyond the status quo – doing things differently by embracing innovation.<sup>1</sup>

Building upon this innovation theme to focus on digital, we explore:

- Why digital is now a reality for mining
- What the future might look like and what is possible
- How mining organisations can take steps to protect themselves from disruption and falling behind the industry or new entrants, while also protecting against poor investments or failure, through:
  - Developing a digital strategy and proactively managing digital transformation
  - Automating operations and digitising assets
  - Building a “digital mine nerve centre” for data-driven planning, control and decision-making
  - Implementing supporting platforms and enablers
  - Leading a diverse, distributed and connected workforce.

Digital is now impacting the mining industry. Technology has advanced such that the barriers of high cost of entry, and a very physical value chain are no longer protection against large scale disruption.



# Why should the mining sector pay attention?

Digital disruption has been changing businesses and operating models, reshaping competitive differentiators and in some cases, completely altering the entire fabric of an industry.

## A new era of business

Digital is a new era of business, a stepping stone in the evolution of the industrial world enabled by the exponential use of technology. Digital disruption has been changing businesses and operating models, reshaping competitive differentiators and in some cases, completely altering the entire fabric of an industry.

For example, 10 years have passed since the launch of the first full touchscreen smartphone. This single innovation is now regarded as a pivotal game changer – having fundamentally changed the way people communicate, consume information, and enabling the creation of entirely new billion-dollar businesses such as Uber.

While the biggest impact has been in consumer-facing industries, there are growing examples of digital transformation in asset-intensive industries such as advanced manufacturing and natural resources. As industries become more data intensive, disruptive technologies are increasingly taking a digital form. Data and specifically the ability to organise, manage, process and utilise that data has become a competitive differentiator.

## An opportunity for mining organisations to reduce waste and create value

For miners, the commodity cycle, cost and productivity pressure means that in many cases the easily attainable savings have gone. As such, innovation is needed to deliver the next wave of improvements.

The potential for digital capabilities to create value by reducing waste is massive: eradicating execution waste by reducing process variability, eliminating process waste by enhancing decision making, reducing structural waste by automating processes and improving systems, and removing design waste by using digital technologies in the design of new assets.

Beyond these cost and productivity benefits (typically targeted at 10-20% improvement), the digital revolution represents a terrific opportunity to forge much closer relationships with stakeholders, facilitate knowledge sharing and training, drive new revenue streams, provide access to new markets and most importantly, make day-to-day operations safer for employees.

# What will the future digital mine look like?

The question for business leaders is how to turn potential benefits into reality. Success for mining companies is not about adopting the latest applications or technology solutions, these will continue to develop and evolve. They must instead embed digital thinking into the heart of their business strategy and practices in order to completely transform the way corporate decisions are made across the enterprise.

To “begin with the end in mind”, we have envisaged the future state digital mining organisation and how this might transform the core mining processes, the flow of information, and supporting back-office processes. This vision of the future state is not based on theoretical concepts or unproven technologies – it is based on capabilities which exist now and are already being applied within energy and resources businesses, but no organisation is yet doing it all in an integrated way.

To effectively lead in a digital mining environment, leaders need to be adept at understanding and driving this change, using data insights to support effective and rapid decision making, and leading a more distributed workforce with fewer people based ‘on site’.

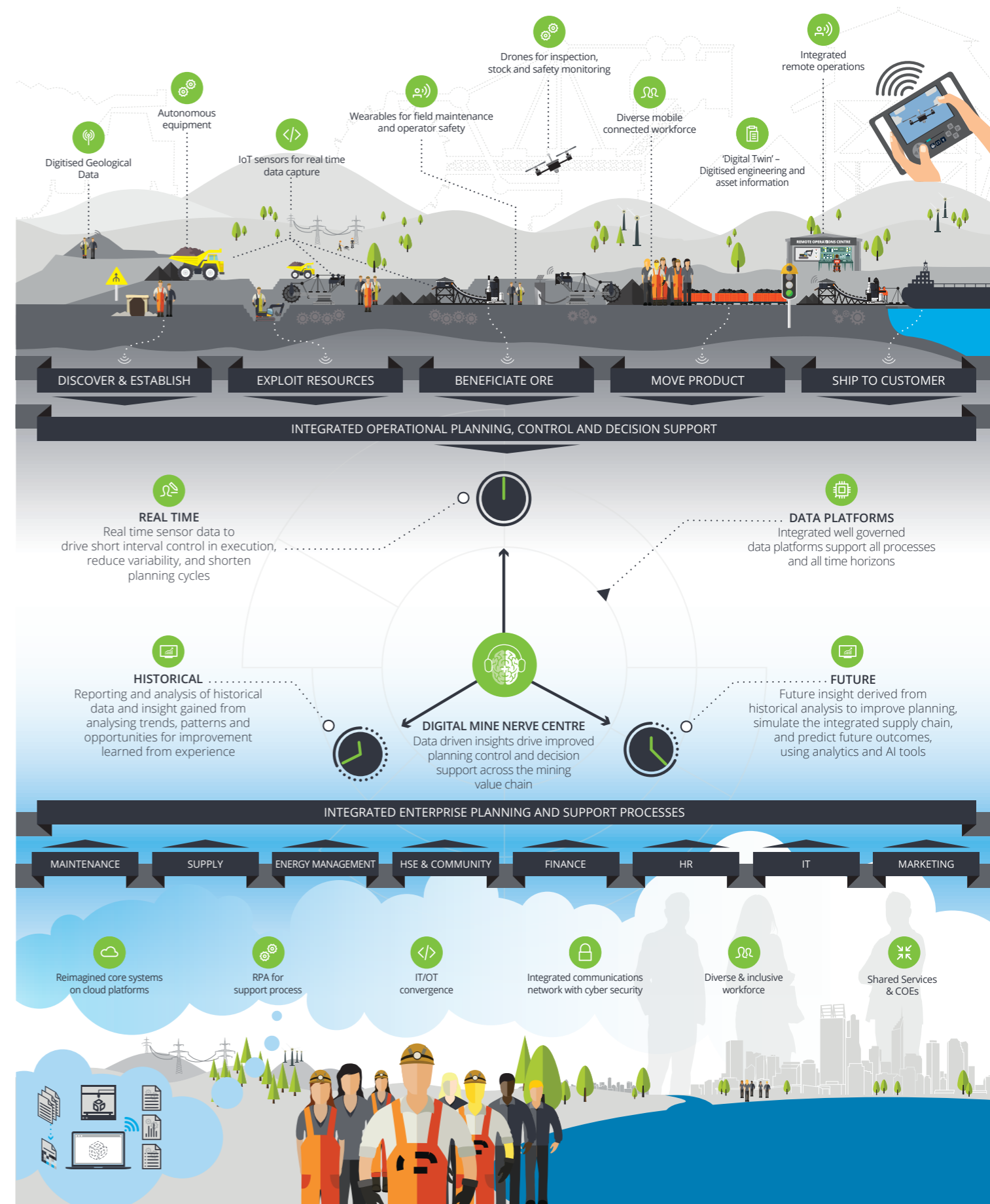
As the location of work becomes more flexible, this enables a more diverse workforce to become involved in what traditionally would have been considered core mining, which also requires new skills and new practices for effective leadership and management.

“I think the industry has not really embraced what digitisation and technology can do. And I think that is the next piece we have to get our mind around and where you should expect to see a quantum change in how we do things.”

**Graham Kerr, South32**  
The Australian Financial Review, 20 February 2017

“Harnessing the potential of digital technology will unlock value across our business, helping us grow our free cash flow per share. In so doing, we will make ourselves into a leading twenty-first century company—enhancing productivity and efficiency at our mines, and improving decision-making and performance across every area of our business.”

**John L. Thornton, Barrick Gold Corporation**  
Businessweek, 13 September 2016



**Core mining processes – automating physical operations and digitising assets**

The core operational processes in the future mining value chain will be highly automated, a wide range of digital capabilities will be deployed.

Autonomous vehicles will improve safety, productivity, and reduce cost (through fuel and maintenance savings). Drones will be used for data collection, inspection, stock control, condition and safety monitoring. 3D printing of critical spare parts will reduce lead times and inventory holding cost. Wearable technologies will be used for field maintenance and real-time machine inspection instructions, improving operator-based care and safety.

A connected network of low cost, highly capable sensors using Internet of Things (IoT) technology will capture data in real time, to enable integrated planning, control and decision support.

A “digital twin” is a digital model of the physical environment constructed using geological, engineering and asset information such as ore body models, engineering drawings, parts catalogues and service manuals. Data from sensors and location-aware mobile devices can then continuously improve the ‘digital twin’, as an accurate reflection of the physical environment. This begins by implementing standardisation of data formats to allow ongoing interaction between systems across the mining value chain.

**Digital in action**

Rio Tinto’s Mine of the Future™ program centres upon driving production while improving health, safety and environment performance through greater automation. Rio Tinto has the largest fleet of autonomous trucks in the Pilbara, and is widely recognised as a leading innovator and as one of the lowest cost producers of iron ore in the world.

Earlier this month, Rio’s driverless train program made its first complete journey without driver assistance, although there was a driver on board to take over if things went awry. Quoted recently, Rio’s CEO Jean-Sébastien Jacques said he took a ride on one of the driverless trains in the Pilbara in September. “It is working very well; we just have to ramp up the entire system, which we want to do in a very safe and structured way.”<sup>2</sup>

Remote operations, combined with all of the above, will result in fewer people in hands-on operational roles, which will improve productivity, safety, and reduce overall cost.

**Globally, 69% of mining companies are looking at remote operation and monitoring centres, 29% at robotics and 27% at unmanned drones.<sup>3</sup>**

**Digital in action**

A Canadian synthetic oil producer’s existing solutions for management of asset information were not delivering value to the business. The data managed within the existing systems was often difficult to find, incomplete or viewed as untrustworthy. Clean-up efforts were met with limited long-term success due to lack of data integrity controls, validation and enforcement within the systems.

To address these issues, the company developed asset and enterprise information management strategies, and selected and implemented a new engineering information platform. The next-generation template solution for management of asset information has been developed and proven at scale through pilot implementation at a major facility, built on principles of supportability, maintainability and minimal customisation.

Consistency of information management at the pilot facility has improved through enhanced business processes supporting creation, update and usage of asset information. Data quality has also been enhanced, and leading edge information management tools which enforce information quality at source have been deployed.



**The digital mine nerve centre – data-driven planning, control, and decision making**

The direct benefits of automation and digitisation in execution will be significant, and even greater value realised when the data is used to plan, optimise and integrate the activity across the value chain.

To fully leverage the automation of core operations, companies will need to rethink the way in which they generate and process information, and utilise data-driven analytics techniques to optimise their complex systems all the way from pit to customer.

The information layer or “nerve centre” of a digital mine will bring together data across the mining value chain in multiple time-horizons, to improve planning, control and decision-making, in order to optimise volume, cost and capital expenditure, and also improve safety.

Real time data derived from processing equipment and machinery sensors during operation will enable short interval control to identify key drivers of process variability, and drive rapid and focused operational improvements.

More timely data from across the value chain will also enable ore-body models, mine plans, and financial models to be updated more frequently, and shorten the planning cycles.

Reporting and analysis of historical data will enable insight from trends, patterns and opportunities for improvement learned from experience.

Future insight will be derived from historical analysis to improve planning, simulate the integrated supply chain, and predict future outcomes. Increasing use of analytics and artificial intelligence (AI) tools will support knowledge workers.

Central to enabling this will be an integrated and well governed data platform to support analysis across all time horizons, and a centre of excellence in data management, reporting and analytics, which employs specialist data scientists and analysts.

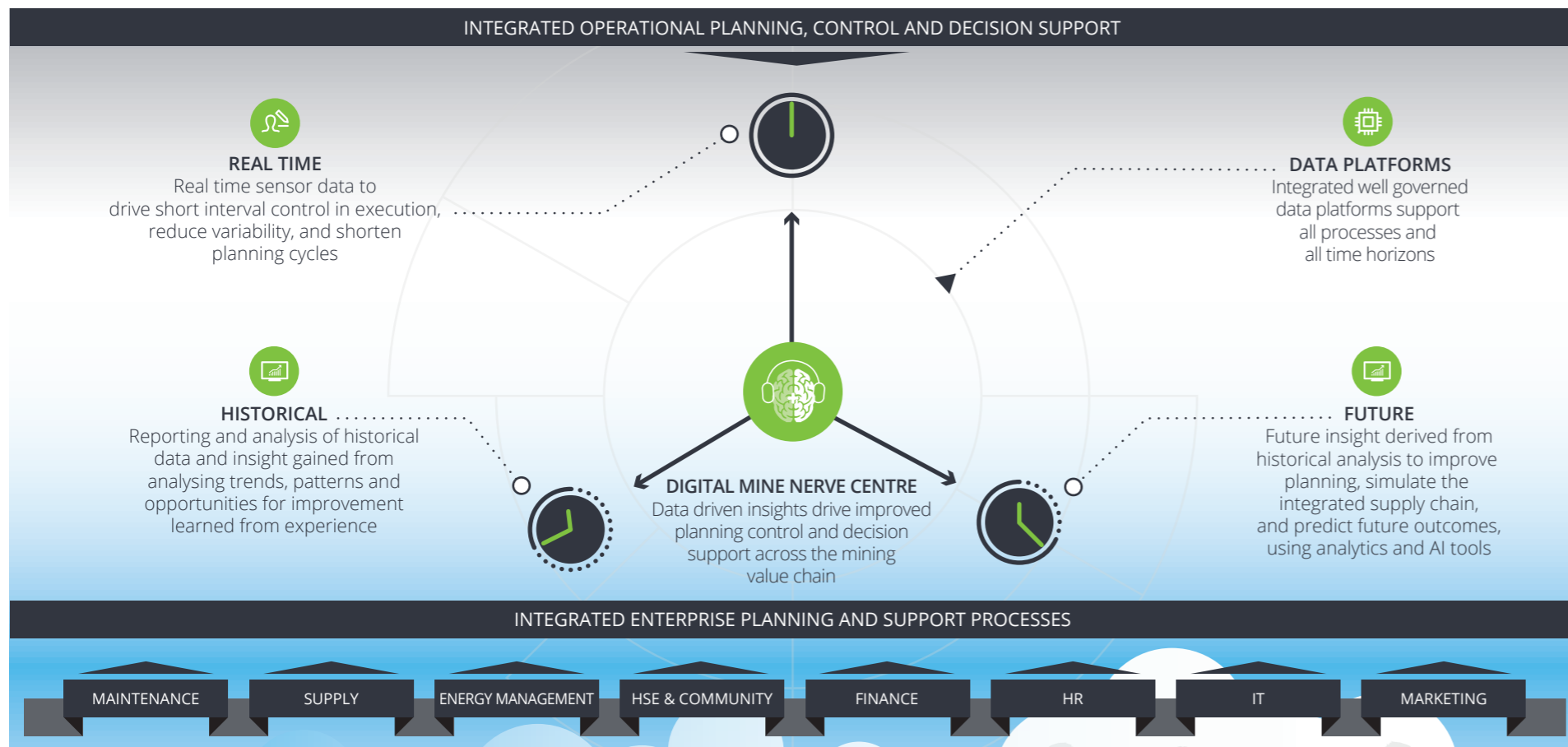
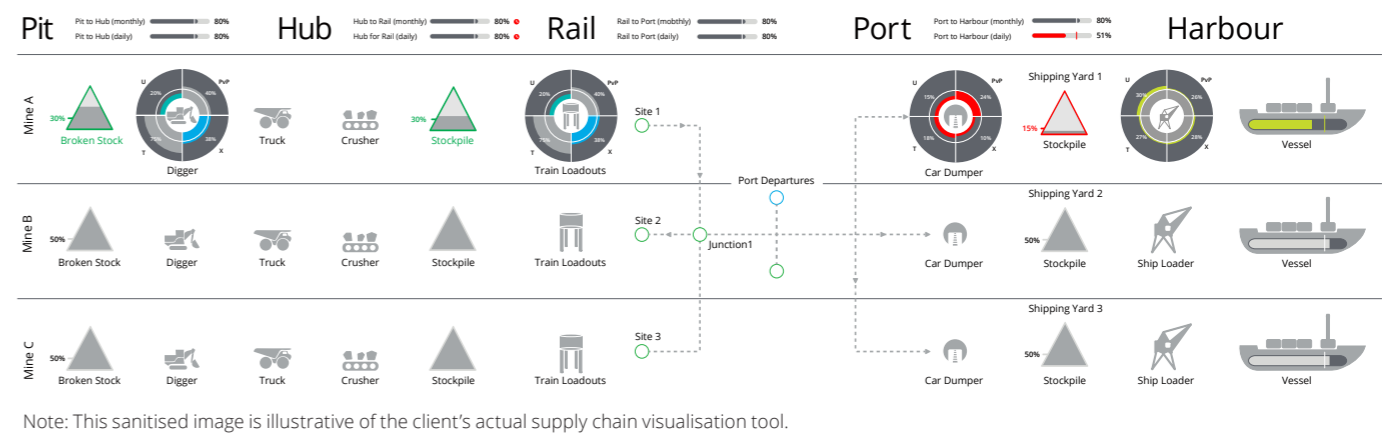
**Digital in action**

Dundee Precious Metals - a Canadian-based international mining company has combined innovative thinking and integrated technology in one of its underground mines. Through an initiative called ‘Taking the Lid Off’, it exhibited the way in which a myriad of communication and location technologies, as well as software systems, can combine to create an intelligent mine management system, including features such as real time production management, tracking and monitoring.<sup>4</sup>

**Digital in action**

A major global miner with multiple iron ore mines in one Australian region moved its short-term production, planning and control activities from the mine sites to its new remote operations centre.

The new operations centre included the implementation of a supply chain visualisation tool that represents an end-to-end (pit to port) view of the iron ore supply chain, showing key operational metrics in near-real-time, permanently displayed on large screens, with data sourced from 16 disparate systems. This was the first time that the client was able to see its total supply chain in one place, assisting decision-making for the whole business.



**Digital in action**

A major global miner was seeking opportunities to identify latent system potential across their pit, rail and port network.

Data-driven analysis generated over two million scenarios to identify significant unrealised value in the system and tested each of them against operational reporting data to measure the feasibility of the proposed changes (i.e. based on historical performance, the analysis determined if it was possible to process, move, or operate in each scenario). This determined the most achievable scenario with the greatest potential increase in value.

The analysis highlighted that higher production and greater shareholder return could be achieved by adjusting traditional assumptions in the mine and system planning. All of this within a system which was previously considered as “at maximum capacity”.

This rapid scenario based analysis is now being used to augment planning decisions on an ongoing basis.

**Support processes – re-imagined ERP and automated support processes**

Finally, the effects of digitisation will extend beyond the core operations and the flow of information to the supporting processes and systems of functions such as supply, HR, and finance.

Mining organisations are going to be challenged to completely re-think their corporate structures, as new entrants to the mining industry without existing corporate infrastructure are able to establish new and innovative models for delivering their non-mining requirements.

There is a strong and growing trend towards not simply upgrading, but fundamentally “re-imagining” Enterprise Resource Planning (ERP) and other support systems, using cloud-based solutions that have a low cost of ownership and contemporary user interfaces.

A lean set of corporate processes will be assisted by robotic process automation (RPA), which will automate repetitive human activities to reduce costs and errors, and artificial intelligence (AI) which will closely support knowledge workers.

The convergence of information technology (IT) and operational technology (OT), and the integrated management of these historically separate domains, is an enabler for automation and digitisation of both core and support processes.

Fully integrated communications networks, leveraging the Long Term Evolution (LTE) spectrum, will support the mobile workforce across all platforms, and cyber security will mitigate the risks of greater connectivity.

Technologies will enable work to be moved to locations which can support a more diverse and inclusive workforce, including primary carers and people with physical disabilities.

Shared services centres and Centres of Expertise will employ a mix of on-shore, off-shore and robotic workforce, with increased human-machine interaction and new and different skills.

**A diverse, distributed and connected workforce will expect an enhanced user experience consistent with the home consumer experience.**

**Digital in action**

Automation is transforming the labour market. Deloitte estimates that by 2035 approximately 35% of current jobs in the UK will be automated.<sup>5</sup> Similar trends are expected in Australia and South Africa. Robotic Process Automation (RPA) tools provide the ability to automate repetitive processes including data gathering and data entry by ‘doing what the user would do’ via a software robot which securely logs into applications and works with the visible user interface to enter information, navigate through screens and extract and process the results.

In other industries such as financial services, where RPA has been widely applied in shared service centres, processing efficiency improvements from RPA have typically been a factor of three to seven times: in other words, a robot typically processes five times what a full-time equivalent (FTE) employee would achieve.

**Digital in action**

A global mining and metals organisation has been a relatively early adopter of RPA within the mining industry. After an initial proof of concept focused on the invoicing process in its global shared services centre, it is now applying automation within its supply function.

The objective was to automate the manual work of the supply team in expediting the material orders and to seek to increase expediting coverage to more than what is currently just the top 25 vendors due to the manual time consuming process, high volume of work and frequency of updates.

The solution included automation of SAP supply data into an integrated data platform, the development of a dashboard for inventory expediting analysis and reporting to site supervisors, and RPA for automation of the vendor communication process.

**Digital in action**

An Australian state government infrastructure agency established a core system program to create one common platform, with one standard set of back-office processes (finance, HR, procurement). This became the foundation for an asset management program to establish a single source of truth for assets.

The solution is based on the core SAP business suite (ECC 6.0) on premise, cloud-based solutions for HR (SuccessFactors) and procurement (Ariba), and HANA Cloud services for selected external applications. The new core systems platform enables and supports the mobile workforce, with a simplified user interface that was not possible with the legacy, end-of-life systems.

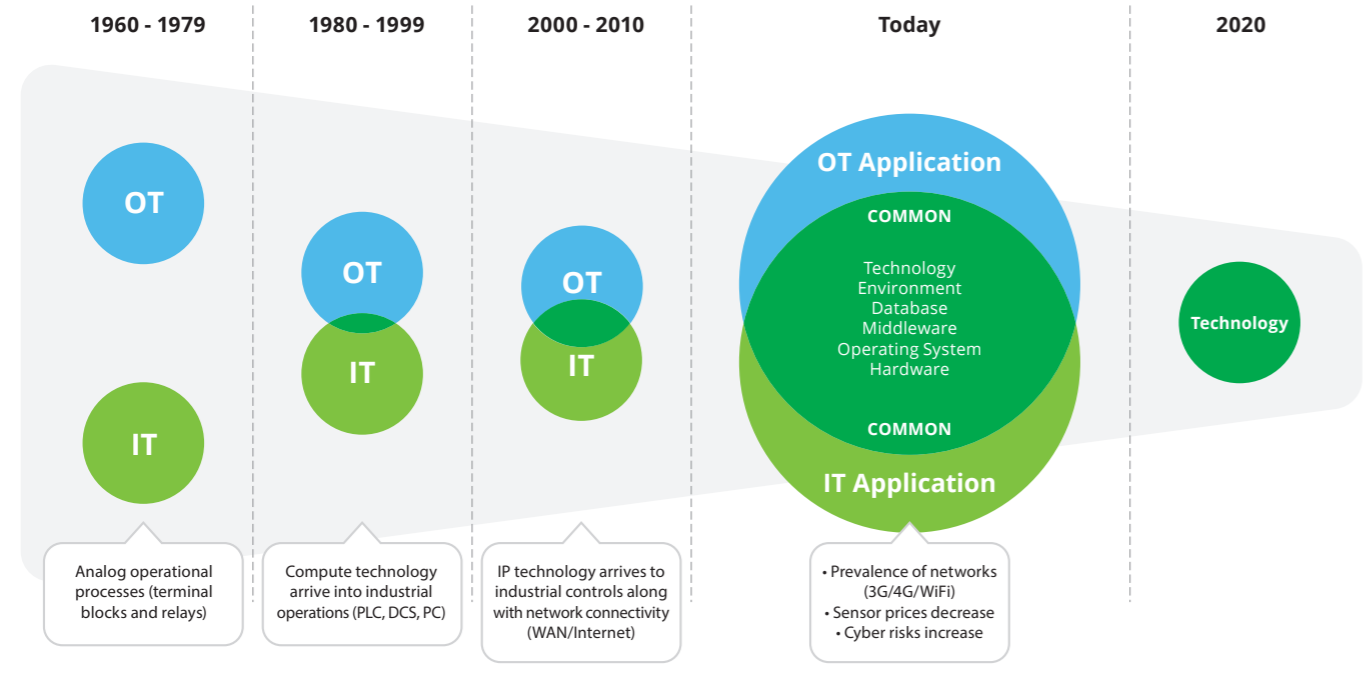
Common standardised processes, combined with greater integration between applications, founded on a single source of data, enable a more holistic view across the organisation, and improved reporting and decision-making. The improved reliability and efficiency of assets is potentially worth billions to the state government over 10 years, in terms of avoidance of new capital from Treasury.





### Digital in action

The convergence of IT and OT has been an increasing conversation point within the mining industry in recent years, and we are now seeing many of the large global miners evolving towards organisational alignment – to remove the historical separation between IT and OT environments – in search of lower operating costs and more efficient teams. Effectively delivering IT/OT convergence is as much a people, culture and change management challenge as it is a technology project.

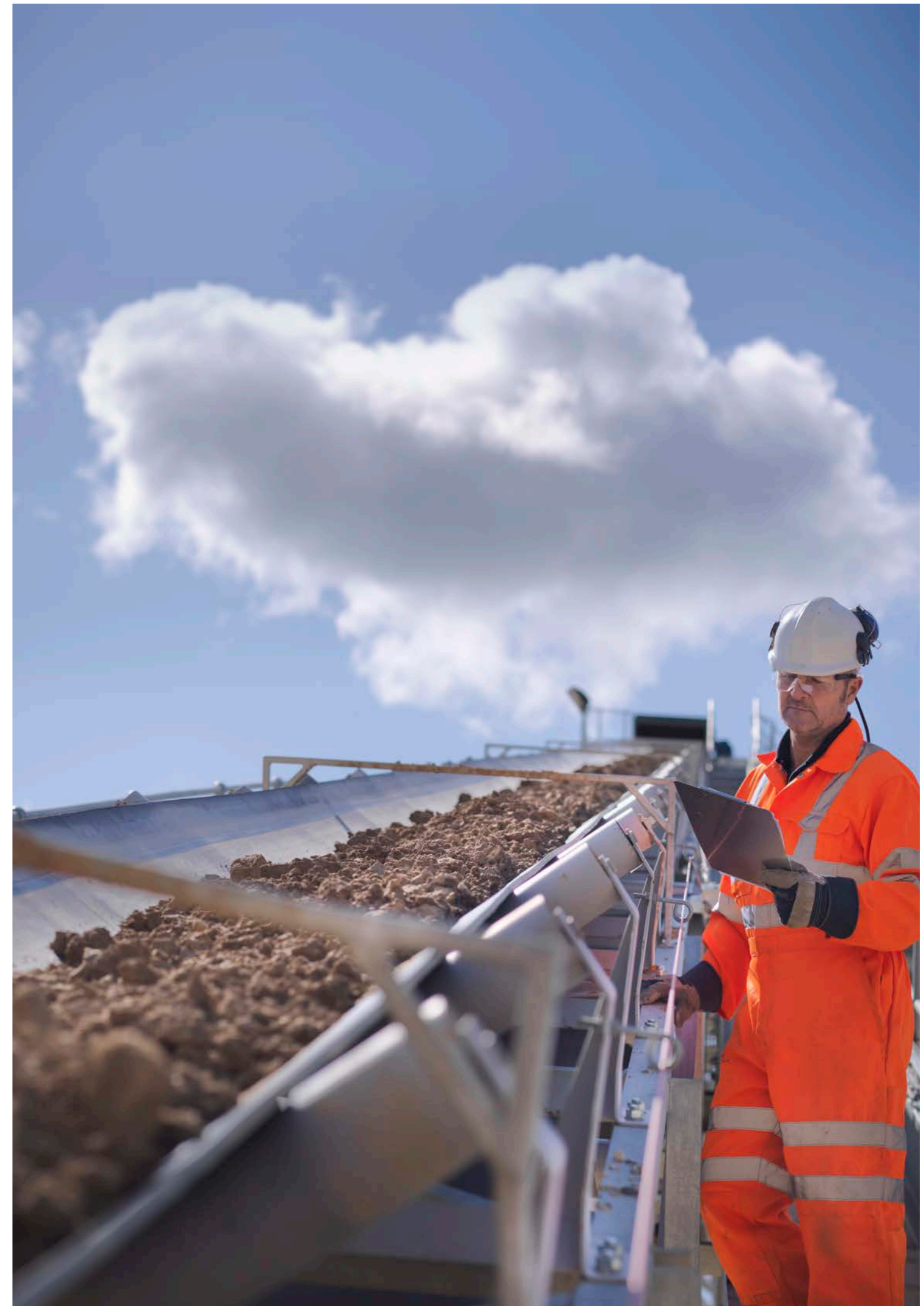


### Digital in action

#### BHP launches online freight platform to sink shipping costs

Reuters, 26 January 2017

"BHP Billiton has launched an online system under which shippers compete to offer the best price to haul cargoes of commodities such as iron ore and copper to the mining giant's customers. BHP this week allocated its first cargo using the auction-style platform, which it hopes will save money as it bypasses brokers who traditionally help negotiate vessel-hire rates between cargo owners and shippers. Such platforms could potentially overhaul the way miners contract freight services, reducing their costs at a time when commodity markets appear to be picking up following years of low prices."



# *How* can mining companies achieve true digital transformation?

## **A measured and agile approach**

Although it can seem daunting to execute on an effective digital strategy, embracing the digital future should not be a make-or-break proposition. Agility will be key, and will likely be a buzzword, but it must be combined with ruthless discipline in driving and demanding value from digital initiatives. This means that strategies that fail are quickly shelved, while strategies that deliver can be rolled out in phases.

A holistic organisational perspective will also be necessary: To leverage the power of digital transformation, miners cannot afford to get caught up in the widgets and toys. Instead, they need to embed digital thinking, processes and structures into their entire organisation in an effort to take corporate decision-making to the next level.

To thrive in the digital future, mining organisations should approach digital transformation by considering the following five areas of focus:

1. Developing a digital strategy and managing digital transformation
2. Automating operations and digitising assets
3. Delivering the “digital mine nerve centre” for data-driven planning, control, and decision making
4. Implementing supporting platforms and enablers
5. Leading a diverse, distributed and connected workforce.

We consider the typical challenges faced by mining organisations, and suggested approaches:

# #1

## Developing a digital strategy and managing digital transformation

Rather than spawning disconnected initiatives, digital strategy has to be motivated from the enterprise level and clearly define the value of digital initiatives to the organisation as a whole.

Digital initiatives are often focused on the technical solution and are not always driven by a well-articulated vision and strategy, nor a direct link to business value. Digital transformation should begin with an understanding of the desired future state, and the value to be created.

A key challenge in this new digital era is the ability to deliver change at the pace that achieves short-term results (within existing constraints) while maintaining flexibility to enable longer-term transformation. New approaches can be tested in a pilot or sandbox environment, rolled out in phases, or easily shelved.

Another key challenge is the large number of vendors offering products and platforms to provide solutions for many digital opportunities, but no single vendor has a complete solution for the entire future digital mine - organisations will need to be able to manage an ecosystem of providers, which will evolve over time.

# #2

## Automating operations and digitising assets

From our experience with major mining organisations in programs such as autonomous haulage and remote operations, we understand the benefits and key considerations for successful implementation. In this context, collaboration is critical as companies will need to operate in an ecosystem of providers and partners, and will also need strong program management and integration capabilities.

A key question is how many mining organisations have really delivered on the promise of remote operations centres to challenge and change their operations, including taking advantage of a global skillset (most operations centres are still single product/single country focused).

Most asset-intensive organisations face challenges with management of engineering and asset information throughout the asset lifecycle, including data integrity issues and time wasted looking for documents. An initial step towards the creation of a "digital twin" should be an assessment of engineering data management (EDM) capabilities and maturity, to highlight the gaps and focus digitisation efforts on the areas of greatest value and impact.

# #3

## Delivering the digital mine nerve centre

To deliver on the digital mine nerve centre, companies must establish a capability to use data to resolve a wide range of business problems. In essence, intelligent business decisions will ultimately hinge on access to timely and relevant information, in all time horizons.

Most organisations only use a fraction of the data they are already collecting, let alone the potential real-time volume that could be captured via IoT, and many are still struggling with limited business intelligence capability from historical ERP environments and non-integrated operational systems.

Skills and experience in data science and analytics are in demand and scarce. Establishing the capability for an insight-driven organisation requires developing and embedding data science and analytic skills across the organisation, as well as the foundational data platforms and analytic tools.

# #4

## Implementing supporting platforms and enablers

Today, many roads to digital transformation are blocked by core systems such as ERP, which are often expensive to run and maintain, and inflexible for future changes. Upgrading core systems to cloud-based applications and platforms can deliver total cost of ownership (TCO) benefits (typically in the range of 20-40%) and improved user experience, as the capability of these solutions, and the associated "as a service" business models, have matured.

Around the edges of core systems there are typically many manual processes and spreadsheets. Complementary to core system changes, RPA can replace some tasks currently performed by humans, presenting an opportunity for cost reduction in support processes and shared services. Mining companies should embark on proof of concept and pilot implementations to test the potential benefits and gain experience in a rapidly growing domain.

# #5

## Leading a diverse, distributed and connected workforce

As the digital mine becomes a reality, our interpretation of what work is and how it gets done is constantly changing. The future of work needs to consider the impact of human machine interaction on future work, workforce, and workplace. The future workforce will demand and expect an improved user experience, based on their experience as consumers.

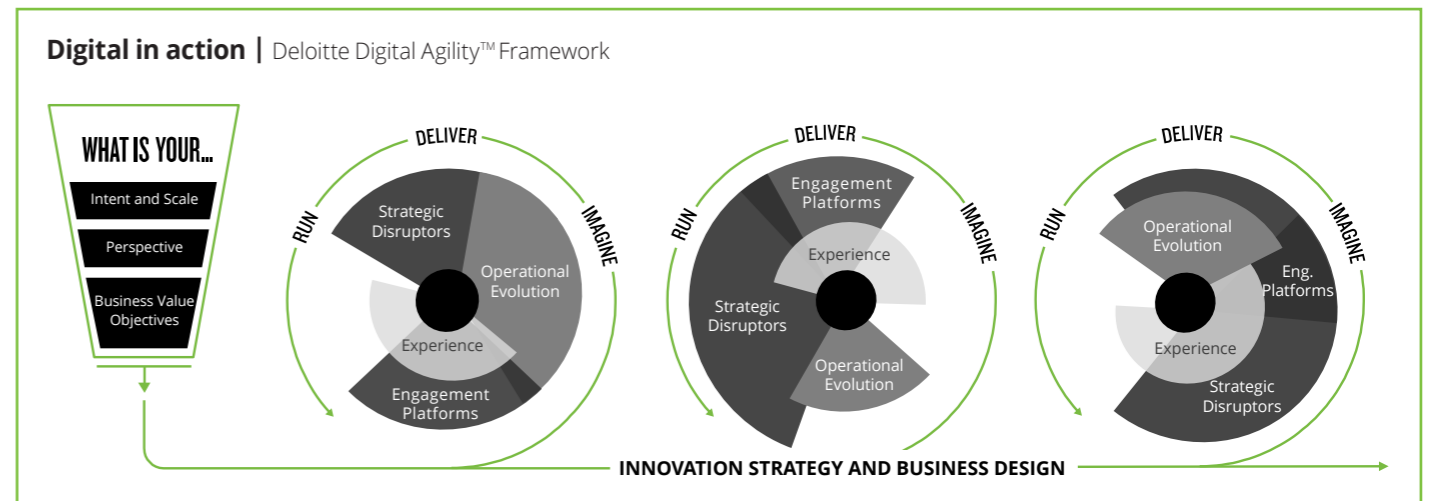
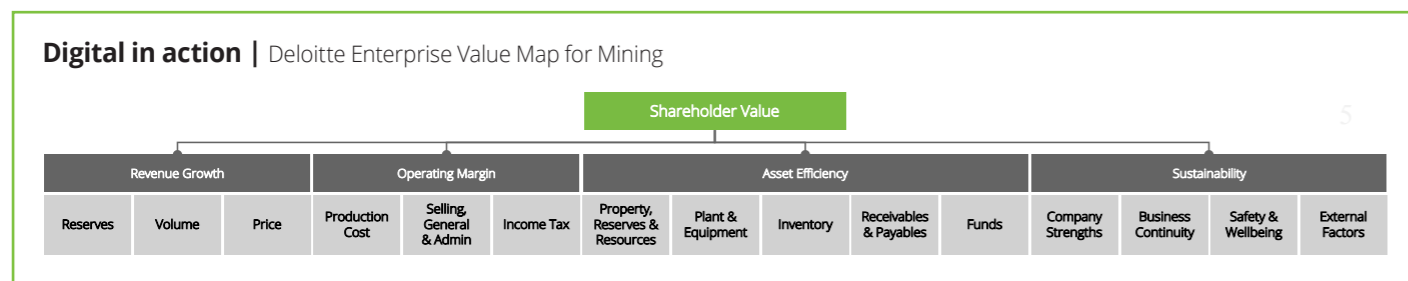
74% of global business executives surveyed by Forrester state that they have a digital strategy, but only 15% believe they have the necessary capabilities and skills to execute that strategy.<sup>6</sup>

The digital mine is an organisation transformation, it requires a new approach to leadership, a culture which embraces data-led decision making and diversity, a new way of operating and diverse and different skills and capabilities. This is no easy task for mining companies, which will increasingly find themselves competing for scarce digital talent. To succeed, companies must bring in these new skills whilst also supporting their current high talent pipeline to successfully make the transition.

Executives serious about reaping the benefits of the digital future must consequently ask some hard questions:

- Can current incumbents make this transition?
- How can they train for new skills and capabilities?
- How can they foster a supporting and inclusive culture?

**74% of global business executives surveyed by Forrester state that they have a digital strategy, but only 15% believe they have the necessary capabilities and skills to execute that strategy.<sup>6</sup>**



# The time to act is now

Digital disruption is absolutely a reality for the mining sector. What we're seeing is that "the mining industry is going through one of the most intense periods of change we have ever seen, and the ability to innovate – to evolve, adapt, and improve – is indispensable."<sup>1</sup>

With the technological landscape rapidly evolving, there's no time to waste. It's clear that "organisations, big or small, that are not able to adapt to this new era of automation are likely to struggle. Although their workforces may have scale, brawn or deep technical skills, they are unlikely to be able to compete against the might of the machines or organisations with a workforce with more adaptable skills."<sup>7</sup>

## Where to start

By understanding the changing landscape and the drivers of these changes, mining organisations can put their best foot forward by equipping themselves with insights and practical steps on how to tackle the challenges and opportunities of a digital revolution.

If not ready for a full enterprise-wide digital strategy and transformation, mining organisations can start by automating specific processes or digitising a pilot set of assets. It's important to deliver solutions focused on business value as quickly as possible, "fail fast, fail cheap", and learn. It's time to get on with it.

With the technological landscape rapidly evolving, there's no time to waste.

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# Authors

For more information please contact a Deloitte mining professional:



**Steven Walsh**  
**Partner | National Consulting Lead, Energy & Resources**  
 D: +61 8 9365 7097  
 M: +61 418 813 302  
[swalsh@deloitte.com.au](mailto:swalsh@deloitte.com.au)



**Paul Klein**  
**Partner | Technology, Strategy and Architecture**  
 D: +61 8 9365 7060  
 M: +61 419 013 405  
[pauklein@deloitte.com.au](mailto:pauklein@deloitte.com.au)



**George Simpson**  
**Director | Technology, Strategy and Architecture**  
 D: +61 8 9365 7048  
 M: +61 416 025 717  
[georgesimpson@deloitte.com.au](mailto:georgesimpson@deloitte.com.au)



**Nicki Ivory**  
**Partner | National Mining Leader**  
 D: +61 8 9365 7132  
 M: +61 422 024 597  
[nivory@deloitte.com.au](mailto:nivory@deloitte.com.au)



**Andrew Swart**  
**Partner | Global Mining Consulting Lead**  
 D: +1 416 813 2335  
[aswart@deloitte.ca](mailto:aswart@deloitte.ca)



**Julie Harrison**  
**Partner | Human Capital**  
 D: +61 8 9365 7061  
 M: +61 404 820 005  
[juharrison@deloitte.com.au](mailto:juharrison@deloitte.com.au)



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