MI4
MINING INDUSTRY 4.0
CRC
Prospectus
Delivering a fundamental step change in value for METS and Miners

The MI4 CRC aims to reimagine the mining value chain through the application of digital and ‘industry 4.0’ concepts. In doing so, this will deliver significant reductions in both capital (CAPEX) and operating (OPEX) costs compared with current approaches. Reductions up to 50% are achievable based on experience from other industries. This offers the potential to make current uneconomic deposits viable and make existing mines more competitive.

**MI4’s Vision**

To achieve a step change in the conversion rates of Australia’s “mineral resources” to “ore reserves” through the development and deployment of digital technologies throughout the mining value chain. In doing so the MI4 CRC research outcomes will facilitate:

- Improved safety outcomes and reduced environmental impacts through precision mining,
- Significant reductions in capital and operating costs for greenfield and existing mines.
- A dramatic increase in the conversion of Australian mineral resources to economic reserves, creating new mines, new jobs and unlocking billions of dollars of value,
- The growth of the Australian METS sector by supplying to the Australian mining industry and growing international export opportunities, and
- Preparing the workforce of the future, well equipped in industry 4.0 and digital practices.

The MI4 CRC will create new opportunities and value for METS and miners by reimagining the mining value chain.

**Developing the prospectus**

This prospectus has been developed following extensive consultation with METS and miners throughout 2018, including workshops and a series of one on one interviews. The industry consensus was that while some progress has been made, the adoption of digital technologies has been largely piece-meal and the gains achieved are significant but modest compared with the potential.

The proposed programs and key activities outlined in this prospectus will be further refined through active industry engagement. Expressions of interest to participate in this CRC bid are sought from miners and METS, with programs tailored for organisations of all sizes and positions in the value chain.
Initial proponents of the Mining Industry 4.0 (MI4) CRC
Context – Why the MI4 CRC?

Challenges to Australia’s position as a global mining leader

MI4’s vision is to achieve a step change in the conversion rates of Australia’s “mineral resources” to “ore reserves” through the development and deployment of digital technologies throughout the mining value chain.

The first wave of digital technologies applied to the mining industry has largely focused on the automation of existing equipment and processes, together with improved data collection and analysis. This has allowed for important but incremental improvements to be made. The MI4 CRC is based on the premise that step change gains can be achieved through the adoption of industry 4.0 and digital technologies, through radical process re design and operation. The MI4 CRC will work with METS and miners to achieve these gains.

Australia is a global powerhouse in the mining sector and home to a modern and growing export focused METS sector. Together Australia’s mining and METS sector contributed some $133.2B in gross value added to the Australian economy in 2015-2016, with an estimate of $10B to $40B contribution directly from the METS sector¹.

METS has been designated as an area of high priority by the Commonwealth government and in Australia recognised as a key industry “high tech” growth sector. The global demand for Australia’s mineral and metal exports is strong, with continuing growth predicted resulting from ongoing urbanisation in China and India. The growing trend of electrification in transport and industry to reduce greenhouse emissions is further fueling metal consumption. For example, an electric vehicle requires in the order of four times more copper to manufacture than an equivalent petrol vehicle.

While a global leader, the Australian mining industry and METS sector faces a range of challenges:

• The increasing scarcity (and increased complexity) of the in-ground resource base, coupled with the challenge of finding large, high quality mineral deposits at or close to the surface.
• Increasing community standards expected and challenges with respect to social license to operate and end of life mine rehabilitation.
• Increased pressure to reduce energy consumption, limit greenhouse gas emissions and reduce waste.
• Increasing global competition through consolidation of service and equipment providers present challenges to the Australian METS industry.
• Having a workforce prepared for the digital mining environment.

Not reaping full value from the global “Digital boom”

Globally, the pace of technological development in a range of industries (e.g.: manufacturing, defence, health and oil and gas) has been rapid over the last decade, particularly in the application of digital technologies and ‘industry or manufacturing 4.0’ principles. The mining industry in Australia has been slower to respond. Focus has been on the automation of existing equipment and better data analysis. While there are pockets of best practice to be found, there is much “catching up to be done. According to McKinsey, “mining is in the bottom quartile of “digitisation” compared with other industries”.2

METS Ignited3 has nominated several key ‘industry knowledge priorities’. The MI4 CRC will specifically focus on the following:

• Boosting productivity and maintenance performance through analytics, connectivity and IoT.
• Optimising material and equipment flow, towards a continuous mining and processing mindset.
• Improving performance and reducing harm through mechanisation and automation.
• Selective mining and processing to boost production intensity.

Significant (up to 50%) reductions in both CAPEX and OPEX are certainly well within the realms of possibility. Mine sites are becoming increasingly flooded in a sea of data, however turning that data into decisions is problematic.

History suggests the potential of digital technologies is often not achieved due to factors other than the technology itself. The MI4 CRC aims to support METS and miners to address the barriers to entry of new technology including the critical issues of change management, encouraging a suitable culture of innovation, provision of education and training and by understanding the regulatory and governance aspects.

Learning from other industries

The mining industry can learn from other industries while there are important contextual differences. A key premise of manufacturing is to closely control the quality and consistency of the inputs and to minimize variation. In contrast, mines are typically highly heterogeneous, with the composition of ore in the ground varying greatly at the macro (hundreds of meters) through to the micro (sub-micron) scale. The aim is to produce a uniform input into the milling process.

Manufacturing (or industry) 4.0 refers to the fourth industrial revolution4:

• First industrial revolution – mechanisation through water and steam power
• Second industrial revolution – mass production and assembly lines using electricity
• Third industrial revolution – adoption of computers and automation
• Fourth industrial revolution – smart and autonomous systems fueled by data and machine learning.

McKinsey5 define Industry 4.0 as “the next phase in the digitisation of the manufacturing sector, driven by the astonishing rise in data volumes, computational power, and connectivity, especially new low-power wide-area networks; the emergence of analytics and business-intelligence capabilities; new forms of human-machine interaction such as touch interfaces and augmented-reality systems....”

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3. METS Ignited is one of the Commonwealth governments industry growth centers www.metsignited.org
4. Forbes Magazine; “What is Industry 4.0” B. Marr, September 2nd, 2018
The case for Australia

Why now?
Minerals are becoming more difficult to find, are generally of lower grade and more challenging to process. Deeper mines are being developed posing additional safety challenges and productivity hurdles. Government regulations and policies need to keep a pace with technology and social developments.

The mining industry also faces challenges related to social operating license and the need for improved environmental performance. The deployment of digital technologies offers great potential to assist.

The imperative for “action now” is compelling:
- The rate at which digital technologies are being developed is exponential, and the Australian mining industry is yet to fully deploy and capture the benefits.
- Australia is either at risk of (or arguably already is) falling behind other countries (notably Canada, Chile and Sweden) in the digital mining space. There is a short time window where Australia can establish a dominant technology leadership position.
- The depth and breadth of skill sets required, including researchers, METS and miners, means a CRC is an ideal delivery platform. MI4 will also leverage international researchers to provide world’s best practice.

For miners
The MI4 CRC will provide digital and manufacturing 4.0 solutions that directly address current barriers to unlocking value in the mining industry, such as:
- Lack of interoperability between systems and platforms.
- Variable sensor capability and data quality specific to mining objectives.
- Lack of tools and capacity to turn data into information for improved decision making.
- Incomplete risk and sustainability management.
- Issues specific to underground applications.
- Limits to the number of digital technologies (same or different systems) that can inter-operate in parallel in real time.
- A sandpit (field trial site) for both METS and miners to explore digital solutions in a risk mitigated fashion.

Critically, MI4 will also provide a platform for preparing the workforce of the future, through targeted training offerings for existing employees in the METS and mining sector and through post graduate programs.

For METS

The Australian METS sector has been a leader in the development of new technologies for the mining industry. The creation of projects within a CRC collaborative project environment offers many benefits:

- Access to operational mining sites and data enabling the acceleration of development and deployment of new technology solutions.
- The ability to work with multiple end users rather than one customer, thus expanding and accelerating the range of commercialisation opportunities.
- Access to the best research providers in Australia, with strong international linkages to solve some of the most difficult industry challenges.
- Exposure to MI4’s network of researchers, industry partners and end users, including access to the best approaches and technologies from other industries.

The value proposition

The Australian METS sector is a key provider to the Australian mining and resources industry and has a global reputation for innovation. Global demand for commodities continues to increase. When coupled with low discovery rates and a long-term decline in the grade of future resources, a step change in technology is critical to improve profitability. Current mining technology is limited to converting an estimated 30% to 40% of Australia’s mineral resources, which have been identified as having reasonable prospects for economic extraction. At this conversion rate most already identified resources will not be developed and remain as “stranded assets”.

MI4 aims to deliver up to a 50% reduction in capital (CAPEX) and operating (OPEX) costs across the mining value chain, making these stranded assets viable.

MI4 Value proposition

The step change reduction in capital intensity and operating cost in mining has, over the next 10 years, the potential to deliver in excess $320 billion for the mining & metals sector (equivalent to 2.7% of industry revenue and 9% of industry profit), to eliminate more than 600 million tonnes of CO2 emissions and the potential to save lives by removing people from harmful energy through automation.

For example, the escalating need for copper will see us mining more over the next 25 years than the total amount mined in human history. This is being propelled both through urbanisation and electrification of energy systems.

7. Based on Measured and indicated Mineral Resources and Ore Reserves as aggregated per commodities by Australian Geosciences. Definitions of Mineral Resources and Ore Reserves as per the JORC Code 2012.
8. World Economic Forum (WEF, 2017) “Digitalization could generate >$320B industry value over the next decade, $190B mining + $130B metals sector (2.7% of industry revenue & 9% industry profit); reduce CO2 emissions by 610Mt; and improve safety - 1000 lives saved (10% decrease in fatalities), 44,000 injuries avoided (20% decrease in injuries)”. 
Reimagining the mining value chain – the surgeon’s scalpel

The application of industry 4.0 and digital technologies provides the opportunity to fundamentally redesign the mining value chain. From a precise knowledge of what minerals lie under the surface and how they are best processed, the objective is to minimise the amount of waste material that is mined, processed and then ultimately discarded. In short, precision mining. Modern keyhole surgery provides a useful analogy.

Keyhole surgery is a minimally invasive surgery. It provides accuracy and allows more rapid patient recovery and rehabilitation.

The application of digital and industry 4 techniques will allow “Precision mining” to occur.

Like keyhole surgery, digital mining offers the potential to pinpoint and selectively extract the minerals and metals of interest. The aim is to:

Maximise the extraction of valuable ore and minimise waste handling.

Thereby minimizing disruption to the landscape and making rehabilitation and continued use of the land quicker, easier and more complete.

Provide a safer working environment by minimising the contact between people and damaging energies.

New integrated mines, utilising automation and optimising technologies can be designed in a very different way, with lower CAPEX and OPEX.

For new mines, digital mining will unlock previously uneconomic ores. For established mines, the application of digital technologies has the potential to increase NPV, ROI and increased cash flow.

No one individual miner, METS company or researcher has the scale, breadth or expertise to fully develop and capture these benefits. The MI4 CRC will harness both contextual mining knowledge with broader technology related opportunities to create value. Unleashing the potential of digital mining will require:

• Mining contextual knowledge,
• A deep understanding of digital technologies, automation and industry 4.0,
• Organisations prepared to accept and maximise the benefits (a combination of innovation culture, training and capabilities).
• Appropriate government policy settings and regulations.

Previous efforts have faltered where one or more of these enablers has not been present. All are critical.

The MI4 CRC will deliver safer, more environmentally acceptable and productive solutions to the world’s growing demand for minerals by enabling fully autonomous and integrated mining operations along the entire value chain.

This will grow the Australian mining sector through enhanced competitiveness, enable new orebodies to be mined thereby increasing reserves, and enable the METs sector to deliver mine automation and integrated mining platform solutions.
Possible programs and projects

Programs

The detailed work programs will be developed in close collaboration with industry partners to ensure maximum alignment and impact. At this stage four cross cutting research programs are proposed:

1. Integrated mining 4.0
   The digital mine will integrate and optimise previously siloed information along the full value chain, and between disparate information systems. Full value chain integration moves mining companies up the maturity curve from a focus on equipment to entire value chain control, simulation and overall system optimisation. It enables METS companies to enhance their offering of automation and systems integration to a global market. The mining value chain can be reimagined based on industry 4.0 and digital technologies. There is little doubt that manufacturing (and other industry) practices have been totally redesigned and this program will explore those opportunities for the mining industry.

2. Automation, simulation and optimisation
   Complete automation will remove personnel from the hazardous operating zone thereby improving safety performance, and allowing access to new or stranded resources, reduce (30-50%) capital and operating costs and reduce environmental and safety exposures. Automation will facilitate steeper surface mining pits and allow underground mines to be designed only for equipment scaled to the orebody selectivity.

3. Social adoption and workforce of the future
   Digital technologies will have a profound impact on the way that mines are designed and operated into the future. For example, the deployment of remote operational centres in capital cities has already changes the way in which remote mines are structured and operated. The future mining workforce will also require a very different range of skillsets for successful deployment. Adoption of industry 4.0 and digital approaches will create a whole range of new job opportunities that are different to the current situation. In short, social change must work hand in glove with technology changes that will occur. The M4 CRC will assist mining companies in managing this change and positioning the workforce for the future needs.

4. Education and Training
   The M4 CRC will play a key role in defining the training requirements for the digital mine and assist the METS sector and mining industry to be positioned and ready for the changes required. The academic partners in M4 are very well positioned to provide specific training courses for METS and Mining staff, and graduate higher degree staff well skilled in the future digital mine.
Projects

Possible project activities include:

1. **Program 1: Integrated mining 4.0**
   - Creating a ‘digital platform’ spanning the mining value chain.
   - Data collection, processing and geosciences capability to numerically represent the orebody throughout the value chain, in real (or ‘right’) time.
   - Fused data systems and standard digital platforms.
   - New sensors or sensor fusion to fill any data gaps.
   - Deployment of advanced, real-time data analytics.
   - Mining software interoperability including shared and interoperable data.
   - Tracking ore through the entire process fusing spatial and temporal data.
   - Software architecture and capability enabling whole of value chain simulation.
   - Multi timeframe planning tools for optimising complex systems.

2. **Program 2: Automation, simulation and optimisation**
   - Advanced control systems based on artificial intelligence and machine learning.
   - Automation of remaining manual processes and interoperability systems.
   - Scaling automated mining equipment for non-human operation.
   - Developing advanced machine human interfaces (e.g.: deployment of haptics).
   - Development and deployment of digital twins.

3. **Program 3: Social adoption and workforce of the future**
   - Defining community expectations for the digital mine.
   - Remote operations and the digital mine.
   - Positioning the workforce for the digital future.
   - Lessons from other industries.

4. **Program 4: Education and training**
   - Training for the digital mining future.
   - Enhancing the entrepreneurial approach to METS and mining.
   - Post grad training for future employees, including industry focused PhD programs completed over the duration of the CRC.
How do I participate?

What is a CRC

CRCs are independently run entities which are jointly funded by industry participants, research organisations and the Federal Government for up to 10 years. Since the inception of CRCs in 1991, 210 have been funded. Over the ensuing years, CRCs have undergone several independent reviews, all concluding that the CRC program has delivered significant economic, environmental and social benefits to Australia.

The Australian Government’s CRC program is a proven model that supports industry-led collaborations between industry, researchers, government and the community within Australia and internationally to develop new technologies, products and services. In 2018, there were 31 active CRCs in Australia.

There are many advantages for companies (small, medium and large) participating in the CRC process, including access to leading research providers, greater insights into the mining value chain, learning’s from other industries, funding leverage and networking opportunities.

The CRC bid process is highly competitive. The MI4 CRC will bid into the 2019 Round 21 Federal Government call for CRC submissions.

Next steps

By participating in the MI4 CRC bid process and subsequent formation, organisations will be able to provide input into the research areas the MI4 CRC will focus on, to align with their needs.

Given sufficient industry support, the intent is to submit an application for the MI4 CRC in the Round 21 CRC bid phase, occurring from March 2019 through to March 2020.

We actively encourage Australian (research, industry and government) and international organisations to participate in the bid phase to influence and drive the bid strategy and content. Activities during this phase include:

- Establishing a bid team to prepare deliverables required for the Stage 1 bid.
- Engaging with industry, government and research institutes to refine the scope and confirm the participation agreement.
- Preparing research project agreements with core research institutes and industry participants to build a CRC budget.
- Preparing a bid phase budget.

Participants can join the MI4 CRC bid at any time during the bid phase. Proponents contribute an equal share to bid costs, notionally $20,000 to $30,000, depending on the number of proponents.

With a successful CRC outcome, bid phase proponents will join the CRC as Essential Participants, and their CRC fees for year 1 are reduced by an amount equal to the funding provided in bid phase.

Once funding has been announced the CRC is set up, this includes establishing initial governance structures (appoint Chair, Board and CEO) and working with government to finalise the funding agreement to start in July 2020.
**Term and participation levels**

To provide timely impact and match the pace of change in technology development, the term of the MI4 CRC is proposed to be 5 years, dependent on final research project time lines.

Four participant levels are contemplated as follows (all cash contributions p.a.):

<table>
<thead>
<tr>
<th>Participant Level</th>
<th>Contribution Range</th>
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<tbody>
<tr>
<td>Core participant</td>
<td>$300,000 p.a. and above</td>
</tr>
<tr>
<td>Key participant</td>
<td>$150,000 – $299,999 p.a.</td>
</tr>
<tr>
<td>Associate participant</td>
<td>Less than $150,000 p.a.</td>
</tr>
<tr>
<td>Affiliate participant</td>
<td>Project by project basis</td>
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In addition, participants will be encouraged to provide in kind resources to strengthen the technology transfer process.

**Timeline**

The following dates are indicative, and subject to confirmation by the CRC program.

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Activity</th>
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<tbody>
<tr>
<td>Jan – May 2019</td>
<td>Collect expressions of interest and define research programs</td>
</tr>
<tr>
<td>May 2019</td>
<td>Lodge round 1 Expression of Interest</td>
</tr>
<tr>
<td>May – Sep 2019</td>
<td>Further refine bid, value proposition and finalise partners</td>
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<tr>
<td>Sep 2019</td>
<td>Lodge round 2 Full submission including business case</td>
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<tr>
<td>Feb 2020</td>
<td>Interview process</td>
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<tr>
<td>April 2020</td>
<td>Funding outcomes expected</td>
</tr>
<tr>
<td>July 2020</td>
<td>MI4 CRC commences</td>
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**Contact**

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