UPDATE: As of July 1st 2019, MI4 CRC has secured 36 partners, including 22 METS and mining companies, Austmine, AusIMM and a national network of Australia’s premier research organisations. Our partners span the entire mining value chain and range from SME’s to multinational companies.
A message from the Chair Designate, Erica Smyth (AC)

Dear colleagues,

I am delighted to introduce you to the MI4 CRC bid and would like to encourage your participation in this ground-breaking initiative.

If successful, MI4 CRC will provide METS and Mining companies with a springboard for the development and implementation of Mining Industry 4.0 principles. MI4 CRC will create, trial and deploy connected and interoperable solutions across the entire mining value chain and has already brought together a unique grouping of METS, Miners and researchers at an international scale. It will also collaborate with other national and state-based initiatives to develop new ways to enable an increased Industry 4.0 capable workforce for the greater METS and mining industry.

MI4 CRC lodged Stage 1 of the CRC Round 21 funding application on July 1st, 2019. As of that time, MI4 CRC has secured 36 partners, including 22 METS and mining companies, Austmine and AusIMM and a national network of research partners. If successful in our funding application, we anticipate a total commitment of at least $106M over 7 years, becoming the largest research commitment of this type and scope in the world.

Four initial Research Programs have been defined each with multiple research projects and activities:

Program 1. MI4 Robust data Integrity
Program 2. MI4 Integration & Interoperability Framework
Program 3. MI4 Solutions development & Implementation
Program 4. MI4 Digital Intelligence ecosystem

We are currently engaging with our industry partners to identify opportunities in these four research program areas, ahead of our final submission in October 2019.

We are still able to include new partners, affiliates and subscribers and encourage new companies to consider and participate in the MI4 CRC bid.

Yours faithfully,

Erica Smyth AC
Delivering a step change in value for METS and Miners

The leadership of Australia's METS and Mining industry is at risk in the digital age unless it can increase its competitiveness. Some mining companies are developing their own, bespoke, digitally based initiatives (such as remote operations centres) but few have developed whole of process systems that are supplier agnostic. MI4 CRC will create and deploy connected and interoperable (Mining Industry 4.0) solutions across the entire value chain. MI4 CRC is uniquely positioned to bring together a grouping of METS, Miners and researchers at an international scale. This will drive increased productivity, competitiveness, capability and sustainability of the Australian mining and METS industries.

Mining Industry 4.0

Industry 4.0 (I4.0) is defined 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 ….” Key principles of I4.0 include interconnectivity, information transparency, supporting human decision making and decentralised decision making.

Mines differ from manufacturing plants in that ore and energy minerals are extracted from highly heterogeneous, finite resources. Decisions made to extract ore today impact on future possible extraction sequences and overall Net Present Value. In addition, manufacturing businesses are constantly investing in new product development and associated retooling/reconfiguration of manufacturing processes. In mining, significant capital investment in plant is required upfront and there is limited scope to significantly change extraction and comminution processes once a mine starts producing. Thirdly, autonomous equipment in mining involve unique field robotics command and control challenges operating over wide geographical areas or in deep underground spaces.

1. Mining Equipment, Technology and Services

Industry 4.0 refers to the fourth industrial revolution:
• 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 fuelled by data and machine learning
**MI4 CRC’s vision**

Australia is already a global powerhouse in mining and METS, and both are critical to the Australian economy. Yet the industry faces strong headwinds from increased global competition, changing commodity consumption patterns, declining ore grades, deeper mines, and remote locales.

The world is moving to cyber-enabled real-time data analysis and decision making, and other industries (e.g.: automotive and aerospace) have been faster to respond with the adoption of I4.0 principles. I4.0 harnesses robotics, automation, digital technologies and skilled people for more efficient product manufacturing, asset tracking and life-cycle management. The Australian mining industry must evolve and ensure the current and future workforce is equipped with the new skills required.

Australian METS are already key drivers of innovation in the mining sector, but need to become more digitally capable and to move from bespoke to generic solutions. Smaller METS companies often find it difficult to interact with large miners, and engagement with research organisations remains a challenge. MI4 CRC will offer direct pathways for collaboration for organisations of all sizes.

The MI4 CRC will provide the vehicle for mining and METS companies to collaborate with researchers to develop new approaches, tools and technologies for a mining-specific version of I4.0. This will enable connectivity and interoperability of different systems across the mining value chain and create a new, integrated, ‘Mining I4.0’.

**Research outcomes**

MI4 CRC proposes to undertake research programs in four complementary areas of integrity, integration, implementation and intelligence – MI4 CRC’s four ‘I’s – to deliver value to the METS and mining sectors.

- **Program 1. MI4 Robust data Integrity:** This program concerns new techniques for the seamless transition from sensor data to more robust information fusion.

- **Program 2. MI4 Integration & Interoperability Framework:** This program will create original equipment manufacturer (OEM)-agnostic, open platforms for interoperability and systems integration.

- **Program 3. MI4 Solutions development & Implementation:** This program will develop fit for purpose, plug & play, cyber-secure digital innovative process enhancements and solutions.

- **Program 4. MI4 Digital Intelligence ecosystem:** This program concerns innovative new learning techniques for growing digital capability by upskilling existing staff and attracting a future digitally skilled workforce.

MI4 CRC will deliver the next generation of integrated mining systems providing a step-change in the capabilities and competitiveness of Australia’s METS and mining sector. It will bring digital and data service providers together in regular forums to exploit emerging opportunities based on a digitally capable workforce. The MI4 will offer new ways of reskilling the current workforce and to train new staff. For example, digital twins (using real data) will be used to train existing staff and to prepare new ‘industry ready’ TAFE and university graduates.

**Developing the prospectus**

This prospectus has been developed following extensive consultation with METS and miners throughout 2018 and 2019, undertaken via workshops and a series of one-on-one interviews. The industry feedback and strong support to date suggests that there is a large amount of research to be carried out before potentially significant gains can be realised.

We seek your engagement to further refine the research programs outlined here. Expressions of interest to participate in this CRC bid are sought from the mining & METS sectors and other key stakeholders, with programs tailored for organisations of all sizes and positions in the value chain.
Context – Why the MI4 CRC?

Challenges to Australia’s position as a global mining leader

The first wave of digital technologies applied to the mining industry have 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 changes can be achieved through the adoption of I4.0 principles. This will allow for radical process re-design and operation. The MI4 CRC will work with METS companies 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 to the Australian economy in 2015-2016, with an estimate of $10B to $40B contribution directly from the METS sector.

The METS sector has been designated as an area of high priority by the Commonwealth government and in Australia is 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 from ongoing urbanisation particularly in China and India. The growing trend of electrification in transport and industry to reduce greenhouse emissions is further fuelling metal consumption.

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

• Increasing scarcity (and 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 expectations, and challenges with respect to social license to operate and end of life mine rehabilitation
• Adoption of the UN Sustainable Development Goals
• Increased pressure to reduce energy consumption, greenhouse gas emissions and waste
• Increasing global competition through consolidation of service and equipment providers present challenges to the Australian METS industry, and
• Having a workforce prepared for Mining I4.0.

Core and key partners: South32, Orica, MineWare (Komatsu), BHP, Incitec Pivot (Dyno Nobel), Hatch, Weir Minerals, Hexagon, Mineral Technologies (Downer Group)

Associate partners: Imdex, ABB, Telstra, AOS Group, MineMax, BMT, Interlate, Whittle Consulting, Australian Droid and Robot, Optika Solutions, Petra Data Science, RedMarble and Singulariti.

National network of research partners: University of Melbourne, University of Western Australia, Curtin University, Monash University, University of Queensland, Queensland University of Technology, University of Adelaide, Central Queensland University and CSIRO.

Association partners include Austmine, the Australasian Institute of Mining and Metallurgy (AusIMM), the Global Mining Guidelines group (GMG), Queensland Field Robotics and Analytics Cluster and Department of Energy and Mining (SA Government).

4. www.sustainabledevelopment.un.org
**Australia is not reaping full value from the global ‘digital boom’**

The pace of global technological development in a range of industries (e.g.: manufacturing, defence, health, and oil and gas) has been rapid over the last decade, and particularly in the application of I4.0. The mining industry in Australia has not been exempt from these changes. Many mining companies are some way behind in the race to adopt equipment automation, remote operating centres and data analytics. This has the effect of a ‘digital divide’ within the Australian mining industry. According to McKinsey, “mining is in the bottom quartile of digitisation compared with other industries”.

Mine sites are becoming increasingly flooded in a sea of data but turning data into decisions is problematic. To be successful, Mining I4.0 principles need to be embraced and supported by key stakeholders. The MI4 CRC aims to encourage a suitable culture of collaborative innovation to support METS companies and miners to address the barriers to entry of new technology.

**Learning from other industries**

The mining industry can learn from other industries while recognising there are important contextual differences. A key premise of manufacturing is to closely control the quality and consistency of the inputs and to minimise variation. Mines, however, 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. Like manufacturing, the aim is to manage variation and to produce a uniform input into the mineral beneficiation process. Other industries that could contribute to the development of the minerals sector include defence, manufacturing, agriculture, oil and gas, and medicine to name a few.

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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 pace with technology and social changes.

The mining industry also faces challenges related to social operating license and the need for improved environmental performance. Mining I4.0 offers great potential to assist.

The imperative for ‘action now’ is compelling:

• The Australian mining industry can gain significant benefits by using rapidly developing approaches to integrate the value chain
• Australia is at risk of falling behind other countries (notably Canada, Chile and Sweden) in the digital mining space. The MI4 CRC aims to build a long-term framework while delivering short term outcomes
• The depth and breadth of skill sets required, including Australian and international researchers, METS companies and miners, means a CRC is an ideal collaboration and delivery platform, and
• Mining I4.0 has the potential to transform Australia from a high-cost jurisdiction to a low-cost producer.

Benefits for METS and miners:

• Ensuring Australia remains as a preeminent location for new mining investment.
• Strengthening Australia’s position as one of the world’s largest exporters of minerals and metals.
• Directly supporting ‘greener’ mining outcomes, resulting from reduced wastage and re-handling through adoption of I4.0 principles.
• Improved safety outcomes through the deployment of I4.0 principles through all mining activities.
• Strengthening Australia’s position as an exporter of METS solutions for the global mining industry.
• Specifically supporting small (or new) METs to ‘turbocharge’ their research programs and to pursue export opportunities.
• Creating a whole new generation of trained people available and capable for MI4 CRC deployment. The MI4 CRC’s programs will span training of industry staff, creating trained apprentices through to PhD qualified staff.
• Cementing Australia’s position as a preeminent research provider in the mining and METS sector.

The value proposition

MI4 CRC will deliver broad strategic outcomes for Australia:

• A knowledge based, high-tech digital service industry that leverages our natural resources,
• A mining industry that is positioned at the forefront of the global mining industry where digital technology plays a significant role in industry competitiveness,
• New digital technologies, processes, tools and approaches that facilitate a local integrated mining value chain that can be exported globally,
• An industry that attracts and retains top talent and creates a wide variety of jobs in regions and cities across Australia, and
• A mining industry with greater social licence to operate through waste minimisation.

MI4 CRC proposes to undertake research programs in four complementary areas of integrity, integration, implementation and intelligence – MI4 CRC’s four ‘I’s – to deliver value to the METS and mining sectors.

Program 1. MI4 Robust data Integrity (from data to information)
In the whole of life mining operation there are many challenges relating to data integrity and accuracy. This program concerns new techniques for the seamless transition from sensor data to more robust information fusion. From ensuring different assay techniques produce comparable data to auto correcting spatial coordinates to mass balance tracking of gold production where data integrity is critical.

Program 2. MI4 Integration & Interoperability Framework (from information to knowledge)
This program will create an OEM-agnostic, open platform for interoperability and systems integration.

Program 3. MI4 Solutions development & Implementation (putting knowledge into action)
This program will develop plug & play, cyber-secure, digital solutions based on open architecture. Applications will be tested using digital twins, using human-machine process modelling and verified, allowing operating mines to plug and play new innovations.

Program 4. MI4 Digital Intelligence ecosystem (growing digital capability for the future digital workforce)
This program concerns innovative new learning and education and training techniques for growing digital capability and attracting a future digitally skilled workforce in a safer working environment. The key will be removing the fear in current workforces by providing new methods of skills development. This will be at all levels from the skilled trades to supervisors to decision makers and will facilitate informed, value-based decisions. Ramping up successful adoption of I4.0 techniques is needed across small, medium and large Australian Mining and METS companies.

Value Created

MINING CONTEXTUAL KNOWLEDGE + DIGITAL CAPABILITY = VALUE CREATED
Example projects

The following are a small selection of possible MI4 CRC project activities. They will be shaped and formed in conjunction with industry partners.

**Research Program 1: MI4 Robust data Integrity (from data to information)**

**Exemplar project – Costing IOT sensors for control using machine learning in presence of bad data**

**Challenge:** The deployment of internet of things (IOT) sensors around different stages of the mining value chain can generate petabytes of data, potentially adding value for I4.0 efficient improvements. However, installing IOT sensors has specific economic costs, as does the maintenance of sensors on an ongoing basis. Principled approach to this problem is to understand the problem being solved, from a system control perspective, and determine the cadence (frequency) of decisions that must be made for controllability of that process.

**Methodology:** The solution is to develop adequate economic models of IOT sensors and decide which are the important sensors, what the frequency of maintenance should be, and which sensors can be inferred through AI techniques such as virtual sensors, relying on inference from other sensors. In addition to identify ‘bad’ data and faulty sensors using digital twins by modelling correlation between different sensors.

**Outcome:** Better economic IOT sensor models and more robust data integrity for mine site data.

**Research Program 2: MI4 Integration & Interoperability Framework (from information to knowledge):**

**Exemplar project – Integrated, real time resource reconciliation for production geometallurgy.**

**Challenge:** If the quality of mined material at various points along the value chain is measured, this allows for feedback in real time to update (reconcile) the resource model. Quality measurement is typically available; however, it is usually fed back manually and infrequently, and requires transformation via models to be useful.

**Methodology:** Existing mathematical models (e.g. blast models, stockpile, and mineral processing models) would be integrated with control systems (mining equipment dispatch, processing plant mining and crushing systems).

**Outcome:** New model-based control algorithms capable of rapid resource reconciliation and facilitating production geometallurgy (excavation is adapted to the needs of minerals processing based on ore variability). Experience from petroleum industry has enhanced net present values by 5-10%.

**Research Program 3: MI4 Solutions development & Implementation (putting knowledge into action)**

**Exemplar project – Cyber secure digital twins (sandpits) for METS and mining companies**

**Challenge:** Validating and testing MI4 CRC solutions in a rapid and risk mitigated fashion. Interactions can be complex and involve multiple system sub components. Field testing in mining operations is expensive and time consuming.

**Methodology:** The project will utilise a digital twin testbed (digital sandpit) for developing and testing MI4 solutions prior to deployment and to accelerate implementation outcomes. Digital twins and modelling can be used by researchers to test plug and play interoperability and verify operation and outputs from MI4 solutions developed before application on working mine sites. This is cheaper than testing in the field and accelerates the deployment of solutions developed.

**Outcome:** Digital twins and modelling to test plug and play interoperability and verify operation.

**Research Program 4: MI4 Digital Intelligence ecosystem (growing digital capability)**

**Exemplar project 1 – I4.0 on a Shoestring workshops**

These workshops have proven very successful in the United Kingdom in the oil and gas sector for small companies. They will provide accelerated collective learning opportunities for companies to learn I4.0 principles from other industries in intensive training workshops.

**Exemplar project 2 – Adaptation of digital technology to future workforce**

This program will address the research challenge of creating innovative learning and training techniques and for attracting a future digitally skilled workforce and making the sector attractive to the next generation.
By participating in the MI4 CRC bid process and subsequent formation, organisations will be able to provide input into the research areas, so they are aligned with their needs.

The first stage of the MI4 CRC bid application (Round 21) was submitted on the 1st July, 2019. If the application passes this first hurdle, the second stage of the submission is due later (October) in 2019. The MI4 CRC team is utilising this time to further refine the bid and to identify additional industry partners.

Specific activities in the current phase include:

- Further engaging with industry, government and research institutes to refine MI4 CRC’s scope and key programs.
- Expanding the research project list and identifying interested partners.
- Developing a term sheet that will define the key elements of the Partners Agreement.
- Finalising the Stage 2 bid submission.

We actively encourage Australian and international companies to participate in this current phase of the MI4 CRC bid.

Once funding has been announced, the CRC will be established with a planned kick off date of July 2020.

What is a CRC

CRCs are independently run entities which are jointly funded by industry partners, 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, learnings from other industries, funding leverage and networking opportunities.

The CRC bid process is highly competitive. MI4 CRC has submitted a bid into Round 21 of the Federal Government program.
**Term and participation levels**

The term of the MI4 CRC is proposed to be seven years. Overlaid on this timeframe the MI4 CRC will adopt a project horizon of three years or less, in order to provide timely impact and match the pace of change in technology development. This will balance the need for readily adoptable industry solutions and recognising the profound nature of the industry transformation required. Partners will be active in one or multiple projects.

Three partner levels are contemplated as follows (all cash contributions p.a.):

- **Core partner:** $300,000 p.a. and above
- **Key partner:** $150,000 – $299,999 p.a.
- **Associate partner:** Up to $150,000 p.a.

Partners will also be encouraged to provide in kind resources to strengthen the technology transfer process. In addition to partners, MI4 CRC will be accessible by a subscriber model for SME's, including capability focused training, education and networking.

**Indicative Timeline**

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

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<td>Lodge Stage 1 Submission – complete</td>
<td>Further refine bid and value proposition. Engage with current and new partners.</td>
<td>Feedback from CRC program on Round 1 submission</td>
<td>Submit Stage 2 submission</td>
<td>Interview process</td>
<td>Funding outcomes expected</td>
<td>MI4 CRC commences</td>
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**Contact**

To participate in the MI4 CRC bid please contact

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