



November 2019

CEEC Kalgoorlie workshop

What's next for comminution

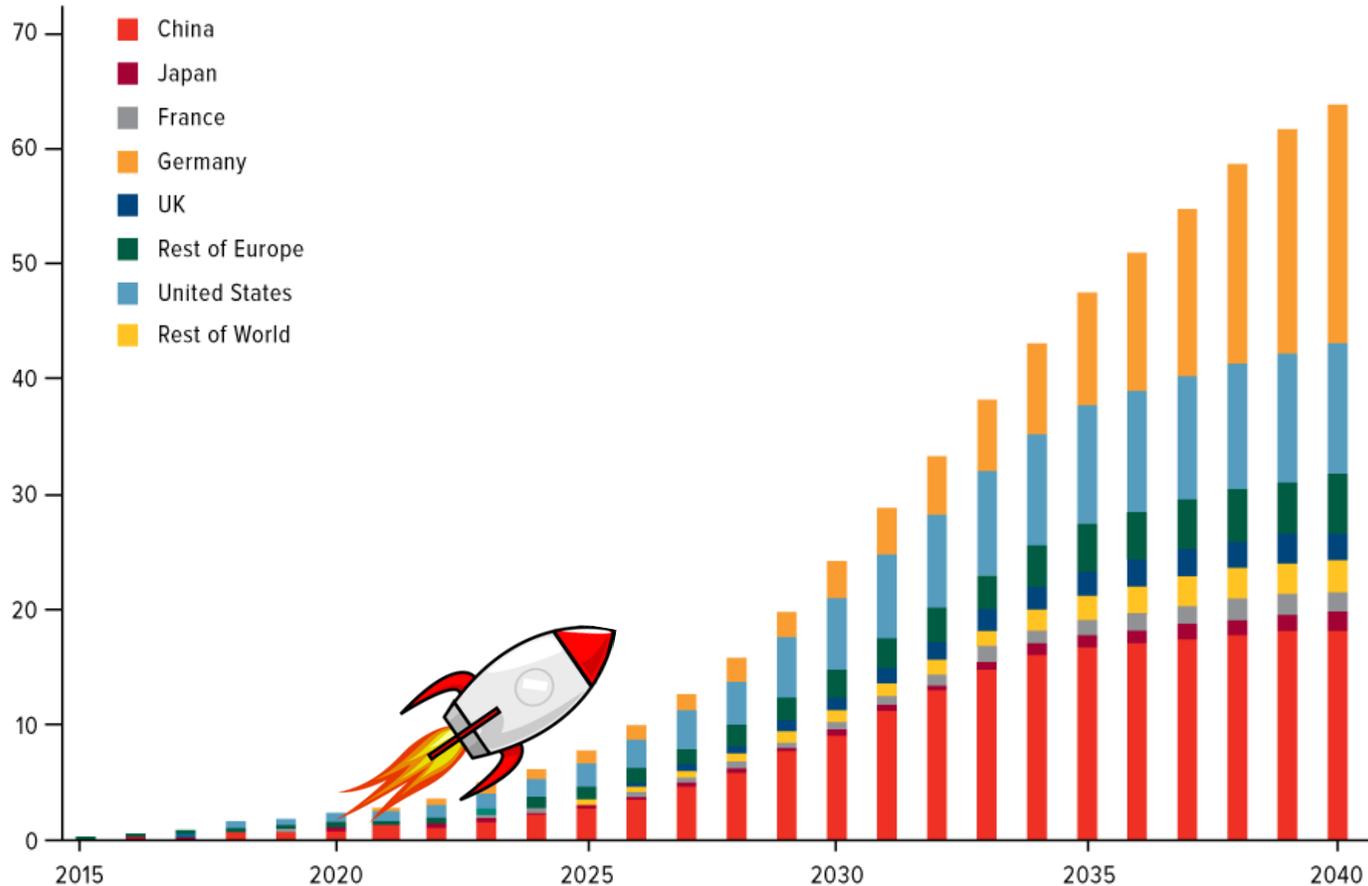


The Electrical Vehicle market is changing the supply/demand equation



Projected Annual Global Electric Vehicle Sales

Annual EV Sales In Millions

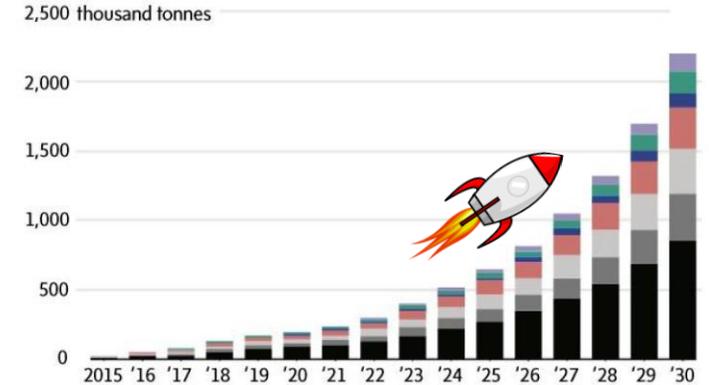


Source: Bloomberg New Energy Finance, Katasa Research, U.S. Global Investors

Demand surge

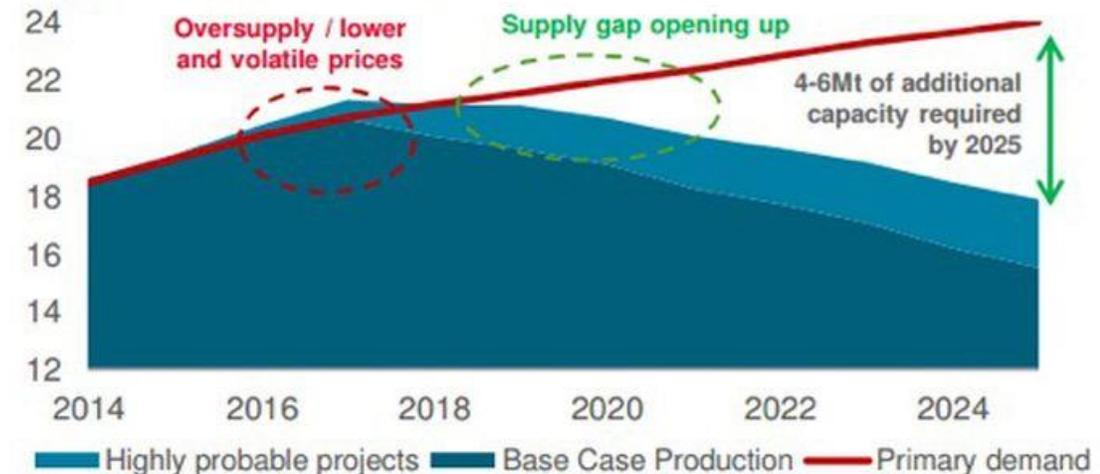
Global metals and materials demand and projected demand from EV lithium-ion batteries

■ Graphite ■ Nickel ■ Alumin. ■ Copper ■ Lithium ■ Cobalt ■ Manganese



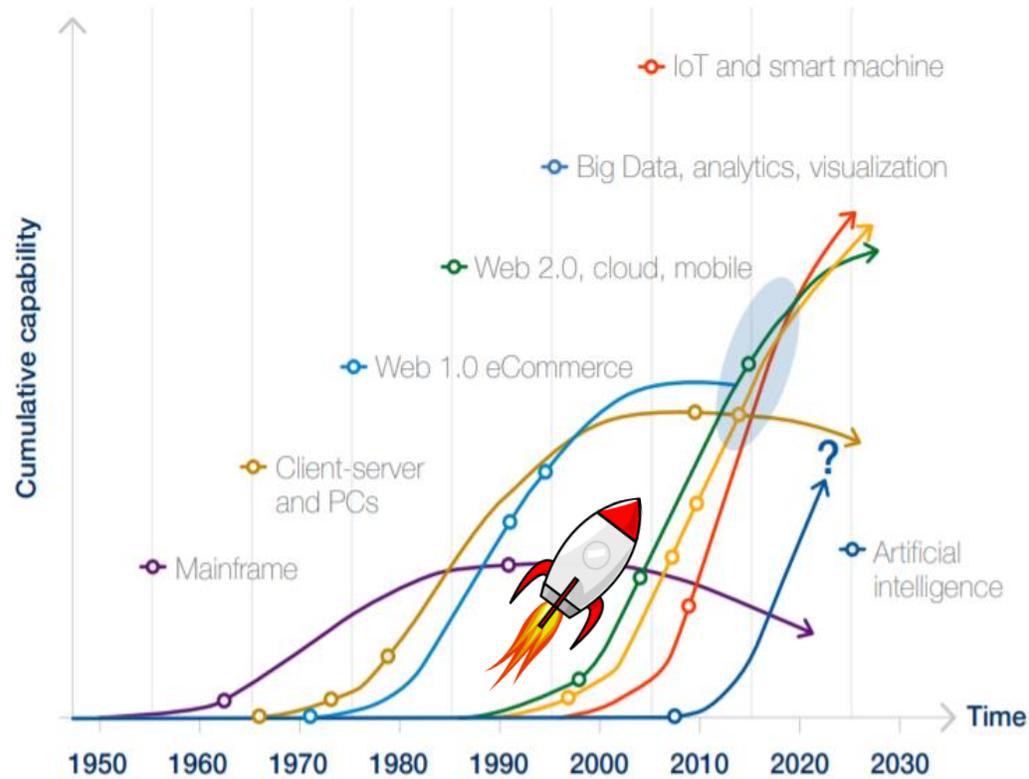
THE GLOBE AND MAIL, SOURCE: BLOOMBERG

Copper supply/demand (million tonnes)



Digital disruption is changing the mining processes

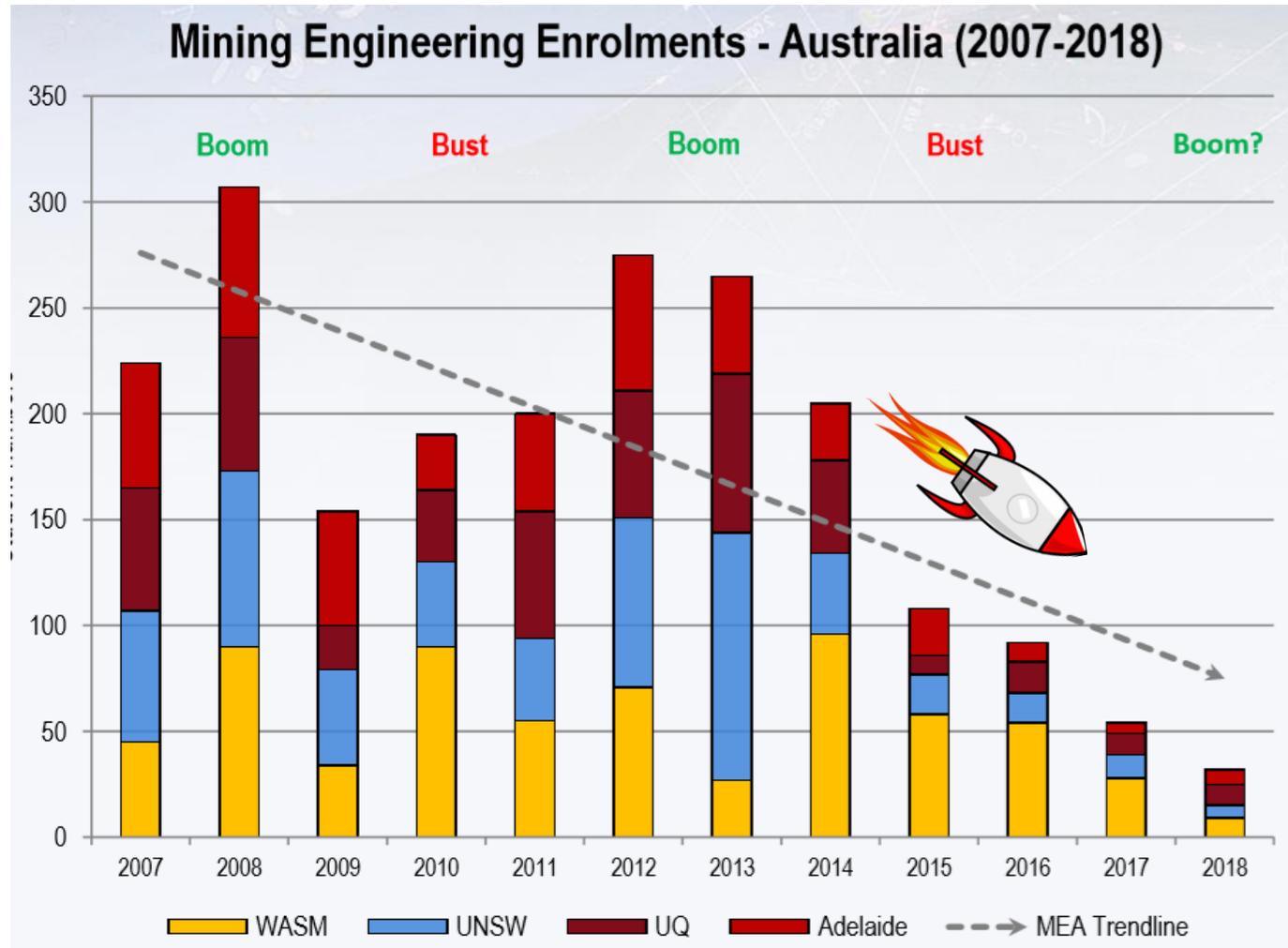
Figure 2: The Increasing Capability of Digital Technologies



Source: World Economic Forum/Accenture analysis

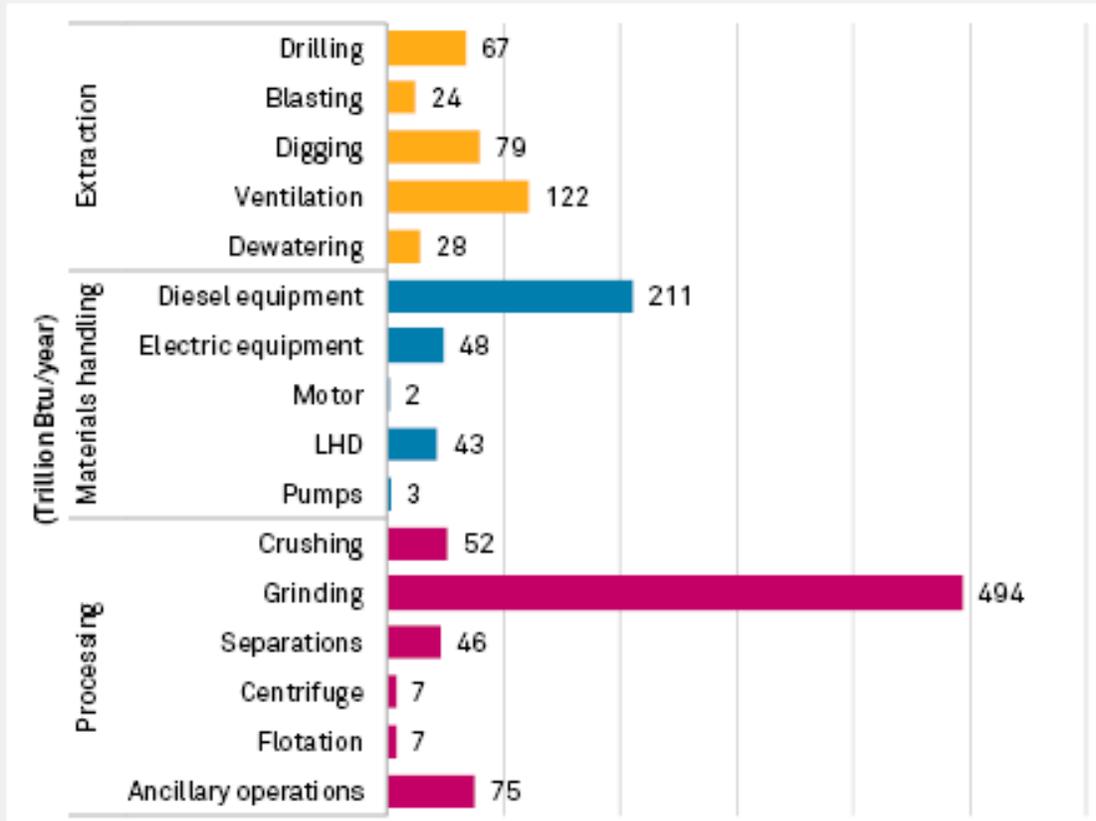


Mining skills at site are declining



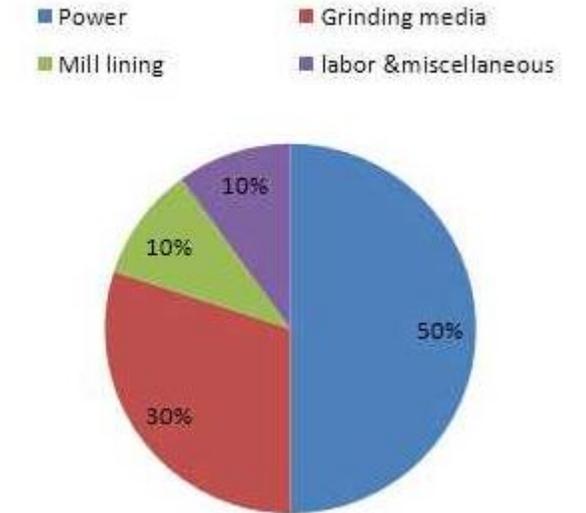
Energy efficiency is an imperative

US industry energy consumption across value chain (coal, metal & mineral mining average)



1 Btu = 3.34334166 x 10⁻⁵ watts
 LHD= load, haul, dump
 Source: U.S. Department of Energy, via VCI State of play research issued Sept. 16, 2019

Grinding Cost Breakdown*



← SAG & ball mill



Drill, Blast and Haul are well advanced in the digital revolution



- Autonomous haul trucks were commercialised in 2008
- There are circa 192 sensors on an autonomous Rio Tinto haul truck in the Pilbara
- Komatsu spend \$one billion per year on Innovation

DO YOU HEAR THAT? IT'S THE SOUND OF YOUR PROFITS RISING.

Every day, your mine sends countless messages in the form of data. Are you listening? Cat® MineStar™ is. It collects data and turns it into insightful information you can use to get more productivity, efficiency and profitability out of your operation. We work with select technologies to tackle your everyday challenges, whether that's controlling costs, extending equipment life or enhancing safety. Then we help you uncover the insights you need to plan your work and work your plan. For surface mines large and small, operating any brand of equipment, there's an ideal mix of Cat MineStar technologies and services—and we're there to help you find it.



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Fleet gives mines a comprehensive overview of all operations with real-time machine tracking and productivity management.

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TERRAIN

Terrain enables management of drilling, grading and loading operations through the use of advanced guidance technology.

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DETECT

Detect enhances operators' awareness of the environment around their equipment, helping alleviate potential safety hazards and increasing operator confidence.

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HEALTH

Health delivers critical machine condition data for your fleet, helping mines identify potential equipment problems long before failure.

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COMMAND

Command allows for remote control, semi-autonomous or fully autonomous mining equipment systems—offering unprecedented improvements in site productivity.

TAKE CONTROL



Digital Twins, Augmented Reality and Mine 4.0



Holograms and virtual reality are used now in mine planning

GE has created a suite of digital twin applications that allows for real-time monitoring across a mine's operations to improve predictive maintenance, mineral recovery and optimisation



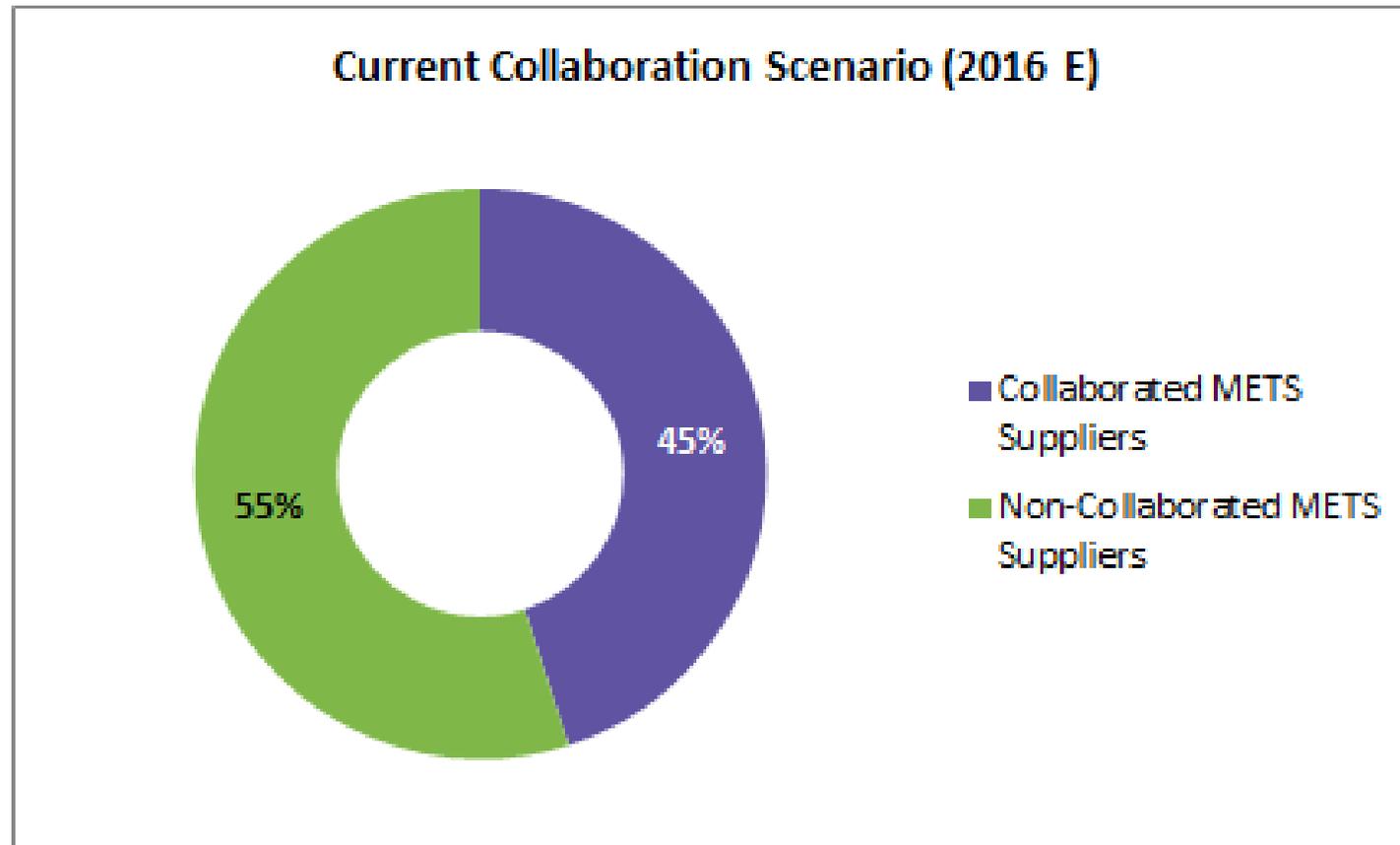
Remote Operation

- Rio Tinto's operations centre in Perth allows the company's mines, ports and rail systems to be operated from a single location.
- It has circa 400 workers at its remote operations plant in Perth



Collaboration is key

- Legacy issue of miners being risk averse and not collaborating well



Source: Austmine national survey



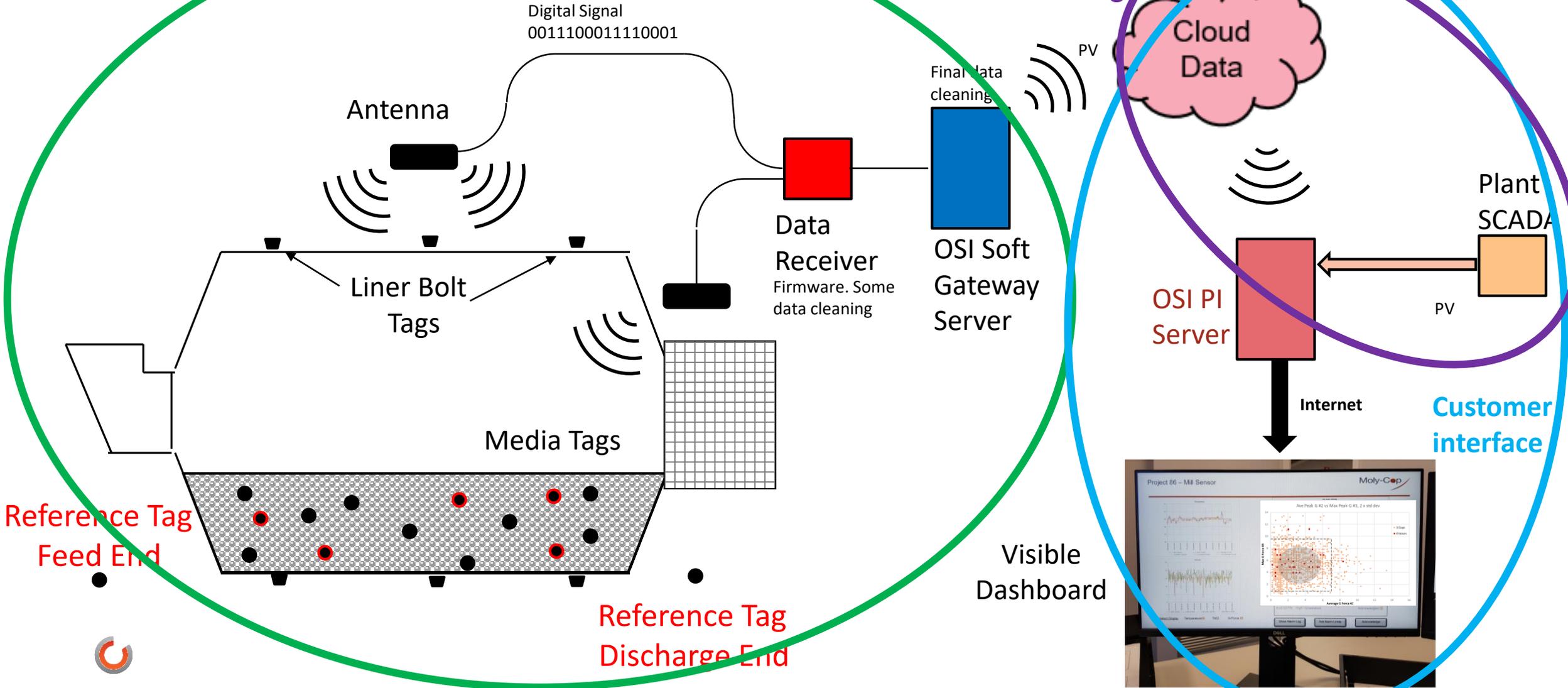
P86 System work elements



Sensor system

Analytics and modelling

Customer interface





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