INTELLIGENT REMOTE MONITORING AND CONTROL FOR OIL & GAS PROCESS & EQUIPMENT

CONTEXT

Energy industry is a capital intensive and safety driven sector, predominantly run by heavy machineries such as compressors, pumps and turbines. In particular, the petrochemical and refinery processes are highly complex with large number of equipment operating in different process, volatile market with low cost steers and hazardous working conditions with fewer manpower; With the advent of technology era, these facilities are becoming more digitalized, paving way for remote condition and performance monitoring, helping operators to gain the visibility of the end-to-end process and empowering decision makers with big data to optimize the overall process, identify safety and environmental hazards to develop a safer working environment .

The industry is also actively looking at opportunities for Proactive Condition Monitoring of equipment to predict premature failures and evaluate their health to avoid long equipment outage through opportunity-based maintenance. In addition to production loss from unplanned downtime and expensive repairs, there is inherent Process Safety risks as unmitigated failure can result in loss of containment with escalating risk of fire/explosion. The advantages of continuous condition monitoring system are widely recognized. For remote location and existing facility, installing wired transmitters may not be **cost effective** as it requires wired infrastructure with power supply, cabling and other civil works. In such cases, wireless system is beneficial as it can be easily installed in remote locations, without power supply/wiring at a fraction of conventional expense.

However, wireless monitoring solutions suffers from following challenges hindering its widespread adaption:

- **Limited Data Availability and Accuracy** – Due to the sheer number of equipment, sensors are commonly used to monitor only the production and safety critical parameters. Even so, such data is often not updated in real-time due to limited data connectivity within the sites.
- **Limited Overview of Entire Process Operations** – Due to the wide variety to equipment used, the centralised data centre receives various types of data (e.g. flow, temperature and vibration). As the wide variety of equipment operates on different communication protocols (e.g. Bluetooth, 4G, LoRa-WAN, WirelessHART), there is a lack of an integrated platform that is able to communicate with multiple protocols providing a complete and comprehensive overview of the entire facility operations. Hence, data scientists/engineers often spent much time dissecting and extracting the needed information before finding the information they need.
- **Manpower-intensive** – Manpower is also deployed regularly to check the sensor readings on different equipment and conduct equipment maintenance, which greatly increases the resources, costs and time of operations. For example, wireless sensors using batteries as a power source requires a change of batteries every 18 months or so.

- **Environmental Hazards** – As many products are highly flammable and explosive, there is an inclination towards remote and wireless sensor equipment to reduce the risk of deploying manpower to collect the readings. However, there are still sparking risks especially when any leaks occur.
- **Limitations of wireless solutions** – Wireless solution are often limited as they are often not compatible with multiple networks (e.g. 4G/5G), have low latency leading to slower response time, and are less reliable in consistently transmitting the needed information.

Consequentially the facilities are looking for an accurate real-time condition monitoring system to predictive maintenance, and identify new avenues for growth.

The second run of **ARTC Startup Challenge 2021** is organised by the Advanced Remanufacturing and Technology Centre (ARTC) in partnership with IMDA and A*StartCentral. The theme for ARTC Startup Challenge 2021 is "**IIoT for Advanced Manufacturing**", and there are three challenges launched.

The Advanced Remanufacturing and Technology Centre (ARTC) is led by the Agency for Science, Technology and Research (A*STAR), in partnership with the Nanyang Technological University, Singapore (NTU Singapore), with a membership consortium with over 80 members.

PROBLEM STATEMENT

How might we enable **inter- operability among existing legacy** and **newly installed sensors** of different wireless protocol and network for remote monitoring and process control using IIoT solutions?

WHAT ARE WE LOOKING FOR?

A prototype solution that integrates wireless sensors of different protocol and network into existing legacy to support for wireless and real-time remote monitoring and process control with following:

- **Real-Time Data Capture:** Ability to capture and transmit accurate data of the asset in real-time and send to respective data centres and/or cloud database. It must have high data throughput and low latency, for extremely fast response time between signal and action in cases of process breakdown, and removing the need to deploy manpower resources to conduct visual analysis and sensor readings (e.g. vibration readings of pumps) in the daily operational processes.
- **Data Dashboard:** Consolidate the data insights for easy analysis of the data collected to generate timely insights on facility operations, such as allowing early prediction of equipment failure, pre-emptive scheduling of equipment repairs/ replacements, and optimising equipment and facility performance. Data to be captured would include pressure (PSI), temperature, vibration, valve positioning, electrical current, etc.
- **Cost-effective:** Easily deployed on all critical equipment, as well as equipment used for peripheral processes, to provide a complete understanding and control of its equipment operations across the facility.

- **Network Compatibility:** Wireless conditions monitoring and process control solution must be compatible with different networks and communications protocols, such as LORA-WAN, WirelessHART, 4G and 5G networks. For example, WirelessHART sensors which can interact with LORAWAN/5G, or a plugin sensor translator or standalone sensor which can talk with multiple communication protocol can integrate different devices for optimum performance of the system.
- **Site-wide Connectivity:** Solution must be accessible by both frontline and backend employees and would require a mobile connection for those in the frontline.
- **Long-lasting Battery:** Solution must have a robust power source and/or battery management program for thousands of different sensors and process control applications, so that data can be transmitted to data centre reliably and safely while minimising the need for regularly changing of batteries. Problem Solvers can propose various power solutions and data transmissions ratios to overcome this challenge (e.g. wireless charging, a machine learning-driven centralised battery management system to prolong battery life, smart equipment condition sensors that hibernates/transfers data at lower frequency if equipment is healthy).
- **Safety:** Solution should be intrinsically safe and be able to meet the certification requirements of ATEX (not a must during this challenge), in order to be deployed in highly flammable and explosive environments.
- **Secure And Reliable:** Solution must be as reliable as wired solution, to ensure that equipment accurately performs the user's intended action immediately, when controlled remotely.

There are no restrictions on the geographical location of the problem solvers who may choose to apply to this challenge. However, the POC/prototype must be demonstrated in Singapore.

POSSIBLE USE CASES

1. **Expert User** –Adam, a data scientist, supports a petrochemical facility by remotely monitoring equipment health and performance. With limited and erroneous data available, he is struggling to develop a reliable model to predict premature failures and improve production efficiency. With more accurate data, he can divert his focus to build reliable predictive model to improve asset health and efficiency.

2. **Frontline Operator User** – James is a panel operator that works with different equipment that processes different products across the petrochemical facility. Each equipment onsite has a wireless condition-monitoring sensor and process control application attached to it, and the data is collected and transmitted to the main data centre. As the wireless condition-monitoring sensor and process control application system allows for mobile connection and site-wide connectivity, James is able to access the equipment database on his iPad while he is on his site-walk, enabling him to make day-to-day operational decisions on the ground, and make different equipment adjustments (e.g. adjust valve position) via his iPad.

3. **Maintenance/Service User** – Caleb is an equipment maintenance engineer. In the past, he had to physically go to different equipment deployed across the site to assess the conditions of the equipment, record data, and make repairs if needed. With the wireless conditions monitoring sensor and process control application system in place, he can now monitor and assess the conditions of different equipment remotely in his office and be significantly more targeted with his maintenance efforts (e.g. change sensor batteries).

WHAT'S IN IT FOR YOU

- SGD 50,000 of prize money for each winner of this challenge (see Award Model)
- 2 Year Tier 3 ARTC Membership
- SGD 30,000 ARTC Project Credit
- 4-month Accelerator Programme
- Gain access to IMDA's Technology resources and facility for prototyping
- Co-innovate with ARTC with access to their expertise in developing the solution
- Opportunity to commercialise solution for deployment and adoption by ARTC industry members

EVALUATION CRITERIA

The Applicants shall be evaluated in accordance with the evaluation criteria set out below.

Solution Fit	• To what extent does the proposed solution address the problem statement effectively?
Solution Readiness	• How ready is the proposed solution to go to the market? • Is there any evidence to suggest capacity to scale?
Solution Advantage	• Is the solution cost effective and truly innovative? • Does it make use of new technologies in the market, and can it potentially generate new IP? <u>Optional</u> • To share estimated cost for pilot trial, deployment and software support.
Company Profile	• Does the product have user and revenue traction? • Do the team members possess strong scientific/technical background?

Problem Solvers are required to submit a proposal in the form of a PDF presentation with no more than twelve (12) slides during the Submission Challenge period (the "Submissions") for judging by IMDA & ARTC.

AWARD MODEL

30% of the prize money will be awarded to each selected finalist at the start of the POC/prototype development process, with the remainder 70% to be awarded after completion of the POC/prototype solution, based on milestones agreed between Problem Owner(s) and the solver.

Note that a finalist who is selected to undertake the prototype development process will be required to:

- Enter into an agreement with Problem Owner(s) that will include more detailed conditions pertaining to the prototype development;
- Complete an application form with IMDA that will require more financial and other related documents for the co-funding support.

Teams with public research performers are required to seek an endorsement from their respective innovation and enterprise office.

DEADLINE

All submissions must be made by **4th January 2021, 1600 hours (SGT/GMT +8)**. Problem Owner(s) and IMDA may extend the deadline of the submission at their discretion. Late submissions on the OIP, or submissions via GeBIZ, will not be considered.