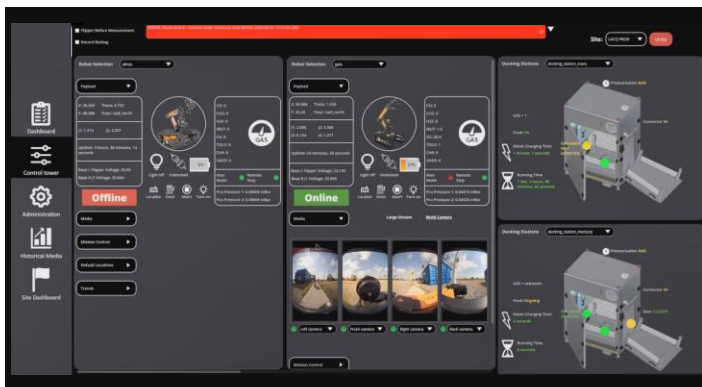




# RMIS – Project Introduction

July 2024

# Rockwell Has Delivered a Robot Supervision System (RSS) – Oil & Gas Production



Role Based Modular Dashboards



Visual Digital Twin

## Solution Summary

The RSS can be used with multiple robot types to provide operators with a single interface. A comprehensive set of Use Cases have been enabled:

- **Robot & Site Monitoring** – payload, site equipment, robot tracking, alerts
- **Mission Management** – creation, scheduling, automation, monitoring
- **Checkpoint Management** – creation, import, management
- **Mission Data Processing (AI/ML)** – image analysis, historian, integration
- **Digital Twin Tools** – site orientation, robot monitoring, robot training.



Multiple Robot Types

## Benefits

- Improved Operating Efficiency through automated equipment monitoring
- Reduced OPEX through the reduction of operational staff on facilities
- Improved safety – less exposure of personnel

## Background

- Rockwell Automation (Kalypso) has been working with TotalEnergies to develop a Robot Supervision System (RSS) for the remote management of a fleet of mobile ground robots. This RSS has reached the first level of maturity and has been deployed to a pilot off-shore production facility.
- The system has been designed based on the experience of TotalEnergies **ARGOS** (Autonomous Robots for Gas and Oil Sites) projects.
- TotalEnergies understood that in order to operationalize ground robots a comprehensive and agnostic application would be needed to monitor, control and automate the robots remotely. The RSS delivers this capability.



TotalEnergies ARGOS



PR Release



SPE Publication



RSS Video

# Introduction

- Objective – The project objective is to finish the RMIS development on DataMosaix with sufficient capabilities and quality to compete in the market.
- Market – Oil & gas, Mining, Metals

We are seeing other oil & gas + mining companies working on autonomous robotics and there is a significant number of opportunities for Rockwell in this space.

Market competition at the moment is limited (Energy Robotics, Drone Deploy and Cognite InRobot) and we have an opportunity to take a leading market position using our TotalEnergies Experience and DataMosaix. +ClearPath experience and could look to integrate ClearPath robots and leverage their software.

## Definitions:

RMIS

Metaverse

Mission instances / Missions

Checkpoint instances / checkpoints

Checkpoint Sequence

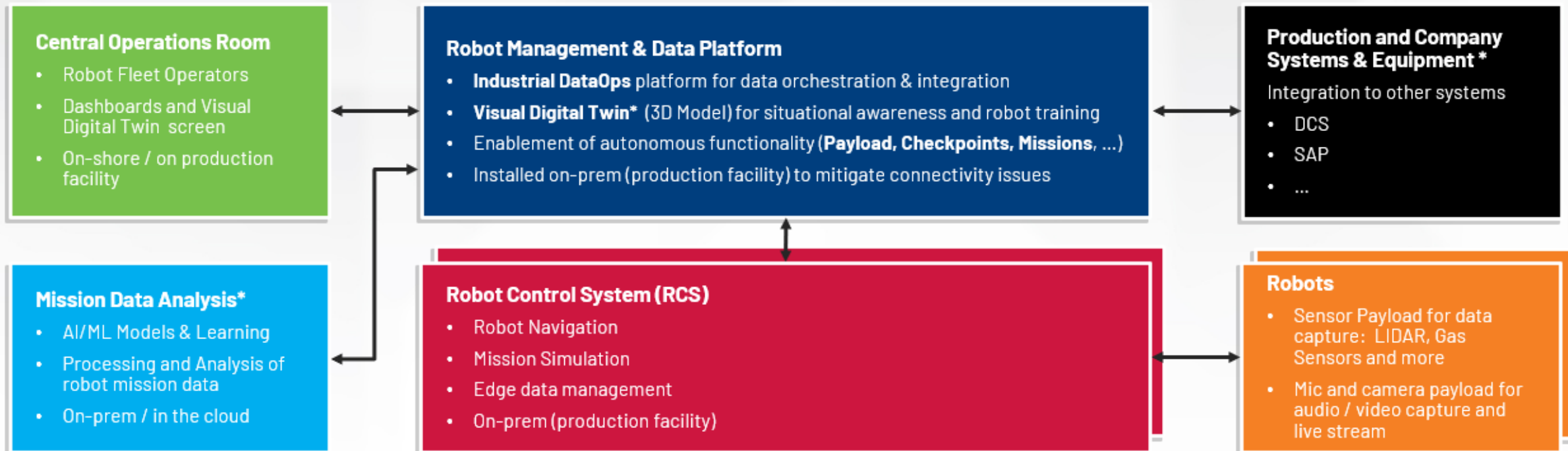
Missions on the fly

Agnostic

FMS / RCS

# Key Components of Rockwell's Robot Metaverse Integrated Solution (RMIS) Solution

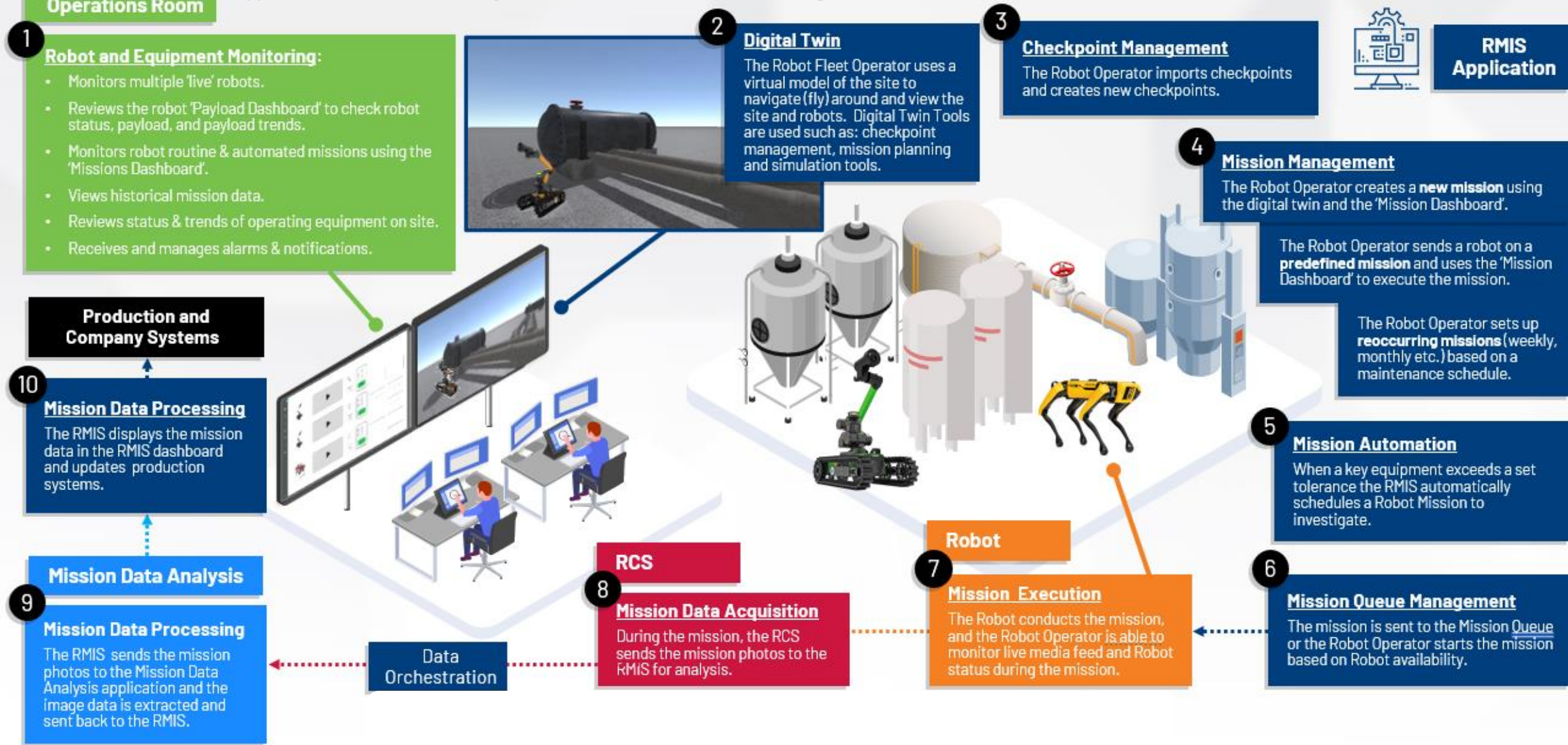
- Designed to enable Robot Operators to work remotely from the robots
- Robot agnostic + multiple robot types with same UI
- Includes mission data analysis & data orchestration
- Designed to mitigate connectivity challenges
- Facilitates robot automation & mission management
- Highly scalable / easy to deploy





# Example RMIS User Journey & Use Cases (UC) for Oil & Gas Inspection

Kalypso has designed a User Journey for a Robot Inspection in Oil & Gas assets, which focuses on the integration of key use cases to deliver an excellent user experience (UX). This is based around the main solution elements; the Operations Room, the Robot and the Robot Metaverse Integrated Solution (RMIS) Application, the Robot Control System (RCS) and Mission Data Processing.



# Robot Metaverse Integrated Solution (RMIS) Features & Capabilities

The RMIS application, in conjunction with the physical robot, robot Control System (RCS), and AI/ML application, enables the uses cases and capabilities summarised below.

## UC-1 – Robot & Equipment Monitoring

- ✓ Management of multiple Robots (Robot agnostic)
- Add new robots of multiple types/vendors
- ✓ Real-time Robot status & payload & trending (multiple robots)
- ✓ Stream Media from the robot cameras
- ✓ Trends of Robot payload
- Alarm, alert and notifications mgt (site & robot)
- Real-time site equipment monitoring & trending
- Trends of site equipment

## UC-2 – Mission Management

- ✓ Missions database
- ✓ Create new missions
- ✓ Start/stop missions
- ✓ Monitor mission progress
- ✓ Mission scheduler (single and re-occurring)
- ✓ Mission queue management
- Mission automation (Closed Loop) – based on site equipment thresholds or alerts)
- Mission optimisation using AI

## UC3 – Checkpoint Management

- ✓ Checkpoint database
- ✓ Checkpoint Dashboard – edit, manage
- ✓ Checkpoint creation. management in conjunction with Taurob EasyMission
- Mass import of checkpoints from maintenance plan

## UC4 – Mission Data Processing & AI/ML

- ✓ Mission data and media historization and visualization
- ✓ Return values for Manual Gauge
- ✓ Gas leak detection (displaying data from robot sensor)
- ✓ Thermal Imaging (displaying data from data from robot sensor)
- Integration with Operational Systems for uploading of processed robot mission data
- Processing and analysis of robot data using ML/ AI & Machine Vision: e.g. vibration analysis, corrosion analysis, liquid leak detection, reading lock-out tag

## UC-5 – Digital Twin Tools

- Robot and site visual & data Digital Twin
- Digital Twin navigation (fly-through, zoom-in/out, etc.)
- Congested area (layering) management
- Robot real-time position & payload visual monitoring
- Robot teaching (checkpoint + missions) – Robot avatar
- Virtual robot camera
- Costmap visualisation
- Add Equipment Tool
- Mission Simulation
- Overlay 360 Pictures Tool

- ✓ Base Feature
- Optional Feature

For ADNOC the following is included in this proposal:

- All of the 'Base' features.

# Taurob - Robot Platform and Robot Control System (RCS)

## SAFETY ABOVE ALL

### INDUSTRY LEADING SAFETY CONCEPT

Industry best practice hazard and risk analysis performed with clients and certification bodies.

## NEED TO TACKLE MULTIPLE FLOORS

### STAIR CLIMBING

The Inspector climbs and descends stairs of up to 45° inclination in order to perform missions on multiple levels.

## EASY INTEGRATION IN SOFTWARE SYSTEMS

### SOFTWARE AGNOSTIC

Taurob's flexible API connects directly to a client's digital twin or seamlessly integrates 3rd party software.

## HIGH RELIABILITY & AVAILABILITY

### RELIABLE AND READY

We are committed to designing, developing and long-term testing in order to achieve maximum availability in the field.

## HUMAN-LIKE PERSPECTIVE

### LONG ARM

Thanks to its three joint long arm, the robot possesses a unique advantage - being able to inspect POIs that were designed for a human perspective.

## READY FOR POTENTIALLY EXPLOSIVE ENVIRONMENT

### ATEX CERTIFIED

The robot is intrinsically safe and fulfils requirements to function in the harshest environments.

## HIGH MISSION ENDURANCE

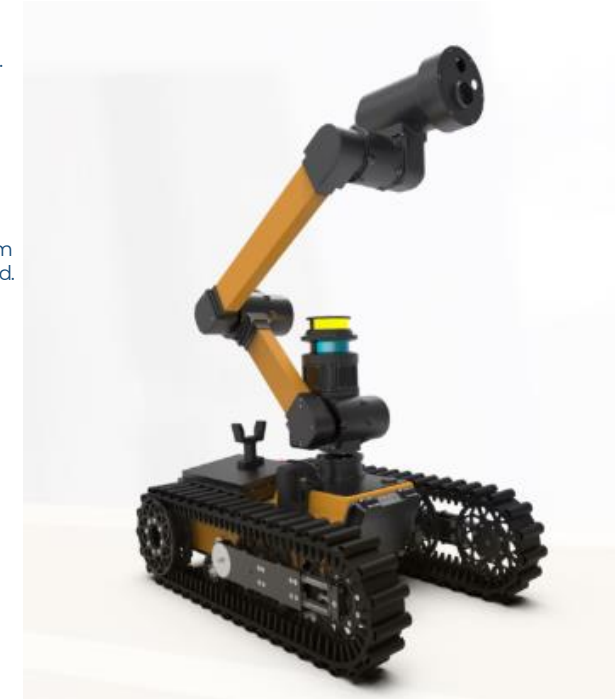
### BATTERY EFFICIENCY

The Inspector performs missions of up to 2 uninterrupted hours and recharges in only 1,5 hours to its full capacity.

## INSPECTION & MAINTENANCE EXPERTISE

### SUPPORTED BY A LEADER

Supported by the expertise of Dietsmann, the leading independent Operation & Maintenance specialist for continuous-production plants in the energy industry.



# RMIS Fit Gap analysis

## Missing features

- Replacement of the Taurob checkpoint & mission database
- Implementation of the flexible missions start / end checkpoints
- Execution of a mission in the Robot Dashboard
- Execution of a single check point out of a mission
- Partial execution of a mission
- Automation of a mission based on a site or robot trigger, e.g. empty battery
- Schedule mission based on robot availability
- Duplicate missions or checkpoints
- Show historical missions / checkpoint in Unity when selected in the dashboard
- Creation of missions from unity
- Show / hide the costmap on demand
- Show the mission sequence in Unity
- Adding Unity tools Add equipment, 360 pictures, notes etc
- Teaching mission
- Gauge recognition computer vision
- Integration of the Flir and Gas sensor
- Integration of the WebRTC stream

## Bugs & Improvements

- Hardening of the Taurob interface
- Improve the error messaging in the UI
- Improve the consistency between Unity and FTD



# RMIS development plan

RMIS development plan												
Phases	IMPLEMENT									Testing		
	WK 01	WK 02	WK 03	WK 04	WK 05	WK 06	WK 07	WK 08	WK 09	WK 10	WK 11	WK 12
	Sprint 01		Sprint 02		Sprint 03		Sprint 04		Sprint 05		Sprint 06	
Key activities	<ul style="list-style-type: none"><li>• Code and data recovery</li><li>• Design reviews</li><li>• KT transfer of the existing application</li><li>• Getting Hands on</li><li>• Bug Fixing</li></ul>		<ul style="list-style-type: none"><li>• Full taurob integration &amp; replacement of the Taurob databases:<ul style="list-style-type: none"><li>– Creation of the Checkpoint database</li><li>– Creation of the mission database</li><li>– Redirection of existing services for data collection and edition</li><li>– Creation of public endpoints for data collection to be used by Taurob</li><li>– Testing of the Taurob connection</li><li>– Hardening of the robot control</li></ul></li><li>• Creation of missions from unity</li><li>• Show the mission sequence in Unity</li></ul>				<ul style="list-style-type: none"><li>• Flexible Mission start / end checkpoints</li><li>• Duplicate Mission Checkpoints</li><li>• History Mission visualization in Unity</li><li>• Single Checkpoint Execution</li><li>• Creation of Missions from Unity</li><li>• Show mission sequence in Unity</li><li>• WebRTC Integration</li></ul>		<ul style="list-style-type: none"><li>• Mission Execution from Dashboard</li><li>• Partial Execution of Mission</li><li>• Automation of mission</li><li>• Further Enhancements &amp; Improvements</li><li>• Testing bug-fix &amp; QA</li><li>• Flir Camera Integration</li><li>• Gas Sensor Integration</li><li>• Implementation Unity Toolbox</li></ul>		<ul style="list-style-type: none"><li>• Package Build and build testing</li><li>• Deployment Testing</li><li>• Final Integration testing with Taurob Robot.</li><li>• Further Enhancements &amp; Improvements</li></ul>	

**RMIS Team:**

- RMIS Solution Architect 25%
- RMIS Technical Lead 100%
- Unity Developer 25%
- 4 RMIS Developers 100% (2 UE & 2 BE)

# Scrum Ceremonies

To demonstrate the outcome of the Sprint and determine future adaptations. Scrum team presents their work to key stakeholders in order to obtain feedback and maintain visibility



To ensure that the items at the top of the Backlog are detailed, estimated, and ready for the upcoming Sprint.

To discuss what went well during the Sprint, what problems it encountered, and how those problems were (or were not) solved. The team discusses ways to increase overall quality and effectiveness of the team.



Process Improvement feedback

2-Week Sprint

Daily Scrum



To review & agree on a Sprint goal, describe the highest priority items, and ask questions to create detailed tasks against the stories in Sprint Backlog



# Scrum Artifacts



**Product Backlog:** A prioritized (ordered) list of everything that is known to be needed in the product

**Product Goal:** *The Product Goal describes a future state of the product which can serve as a target for the Scrum Team to plan against*



**Sprint Backlog:** It is composed of the Sprint Goal (why), the set of product backlog items selected for the sprint (what), plus a plan for delivering the product increment and achieving the sprint goal (how)

**Sprint Goal:** *The Sprint Goal is the single objective for the Sprint, provides flexibility in terms of the exact work needed to achieve it*



**Product Increment:** The sum of all the product backlog items completed during a sprint and the value of the increments of all previous sprints

**Definition of Done:** *A formal description of the state of the Increment when it meets the quality measures required for the product*

# Story points definition

- 1. 1 SP a couple of hours**
- 2. 2 SP a half day**
- 3. 3 SP 1-2 days**
- 4. 5 SP 2 – 5 days**
- 5. 8 SP at least a week**
- 6. 13 SP several weeks**

# ADO

[https://dev.azure.com/Kalypso-Prod/Kalypso\\_RMIS/\\_backlogs/backlog/Kalypso\\_RMIS%20Team/Epics](https://dev.azure.com/Kalypso-Prod/Kalypso_RMIS/_backlogs/backlog/Kalypso_RMIS%20Team/Epics)

Kalypso\_RMIS Team

Backlog

Analytics

Epic/Feature Timeline

Feature Timeline

Epic Roadmap

	Order	Work Item Type	Title	State	Effort	Busin...	Value Area	Tags
		User Story	laurob cloud database replacement	New			Business	
		Task	Database model creation	New				
		Task	Checkpoint & Missions endpoints	New				
		Feature	Checkpoint and Mission execution	New			Business	
		User Story	Mission execution	New			Business	
		Task	Mission execution	New				
		Task	Partial mission execution	New				
		Task	Missions on the fly	New				
		User Story	Checkpoint execution	New			Business	
		Task	Checkpoints execution	New				
		Feature	Automatic mission execution	New			Business	
		User Story	Execute missions on schedule	New			Business	
		Task	Mission automation - Any robot	New				



## **Guillaume:**

S.A. Responsible for the Architecture

Product Owner: Participate to the backlog refinement, making sure that the requirements are clear; Prioritization of the Backlog

Scrum Master

## **Biswa:**

Technical & Team Lead: supervision of the development, responsible for the team coordination, for the quality of the application; for the deployment of the application

## **Don & Mohan:**

Responsible for documenting the work in ADO – keeping ADO up to date; Responsible for the quality of the deliverable; Leading the junior developers in their area of expertise (UI / BE); Responsible for raising the hand in case of issue the latest during the daily

## **Mahesh & Subash**

Responsible for documenting the work in ADO – keeping ADO up to date; Responsible for the quality of the deliverable; Responsible for raising the hand in case of issue the latest during the daily

## **Sonali**

Computer Vision Specialist – Responsible for building AI Analytics to be integrated with the application. Responsible for raising the hand in case of issue the latest during the daily.