

# CONCEPT PAPER – UNIFIED CONSTRUCTION MONITORING FOR CONNECTED CONSTRUCTION ENVIRONMENT

## EXECUTIVE BRIEF

This concept paper elaborates in detail about ‘Connected Construction’- the new paradigm in large, multi-site technologyintegrated building projects. Post-COVID infrastructure build-out is on a rebound, and construction majors are using advanced technologies like Augmented Reality, Wearables, and Drones in addition to Robots and Digital Simulations.

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*Connected Construction ties together real-time data from mobile sources such as robots, drones and 3D glasses with geospatial intelligence and project monitoring solutions - all on the cloud.*

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This vast landscape entails the need for a platform i.e., system-of-systems approach, to **integrate disparate data streams in real-time and provide streamlined multi-site insights and advisories.**



Picture credit/Source: Viewpoint Construction Technology blog

## THE IMPERATIVE FOR A CONNECTED INTELLIGENT PLATFORM

Fragmented data in silos, legacy software and lack of automation, manual processes from planning to real-time monitoring and reporting – are some of the challenges causing up to 8% contraction in margins. Redundant or inaccurate data and disjointed business systems make up 35% of the problem.

## THE KEY DRIVERS FOR A TRANSFORMATION

**MANDATE ARE:** ○ Remote construction monitoring –

reduce physical presence on site

- Comparative progress management
- Enhanced safety requirements with continuous monitoring and rapid emergency response
- Do away with manual inspections of plan-to-progress

- Humongous efforts involved in measurement accuracy and avoiding rework due to errors
- Multi-site inspections with reduced mobility
- Mapping between physical progress and financial decisioning systems



Fig1- Latest Trends in Construction Domain

## BENEFITS OF CONNECTED CONSTRUCTION

The Connected Construction gives better schedule controls and the ability to look at those leading indicators which affect the productivity at the Construction site. It helps to optimize assets, avoid waste and unnecessary delays. All teams – personnel at the construction site, fabrication yard, the engineering team, and Project Management Office - will look at the same data at the same time.

Connected Construction helps optimize the asset performance and utilization and avoid waste. Insight into assets - including real time access to capability, location, and quantity of people and equipment - is key to successful job planning. Accurate

demand planning, avoidance of duplication are key functions of such a Connected platform. Very importantly, it provides realtime multi-directional communications between people, systems, assets, and management.

**Technology aided decision making:** Modern construction practice must adhere to critical safety standards, along with compliance to regulatory policies. This mandates the integration of decision-making technology into their work practices without affecting performance or cost.

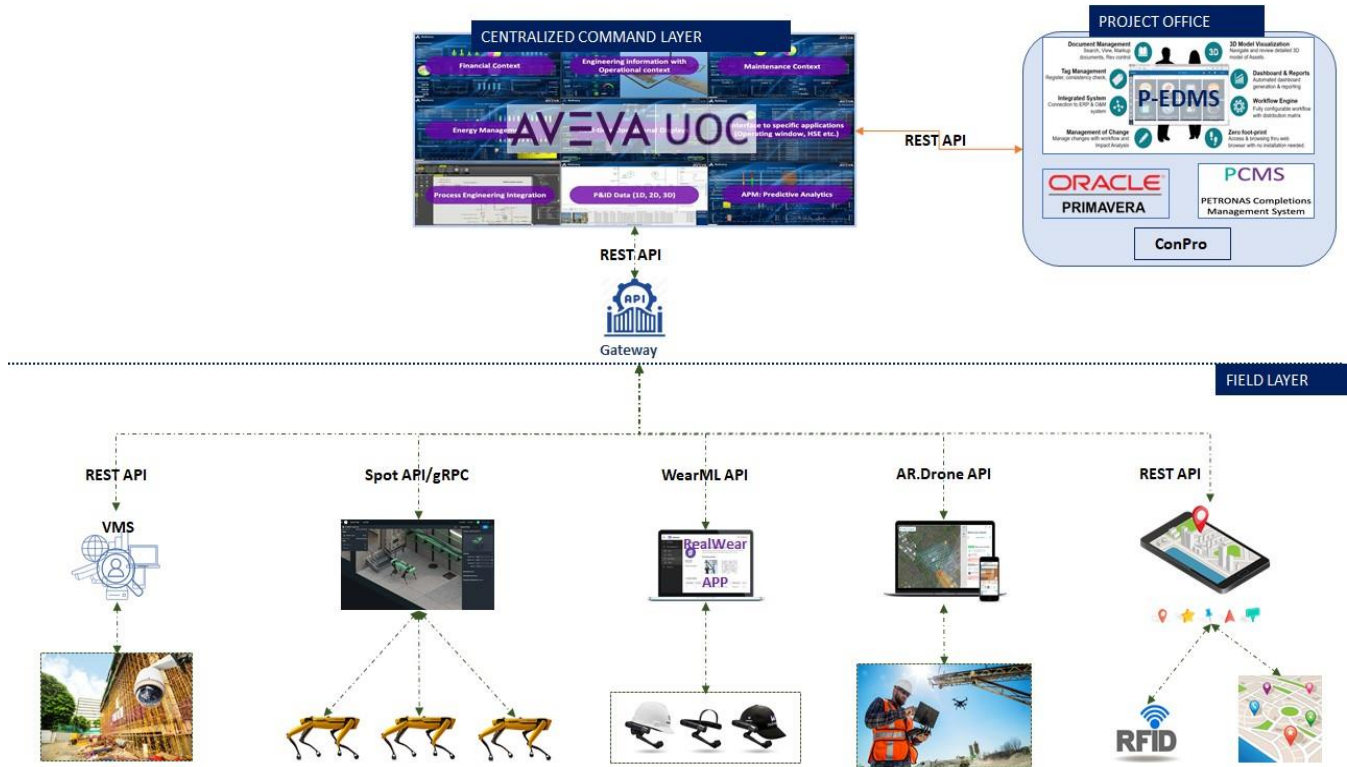
## **AVEVA NET**

AVEVA NET is a web-based Connected Construction Platform developed by AVEVA PLC, formerly Schneider Electric Industrial Software. AVEVA NET helps the organization to realize the full potential of their People, Equipment, and Materials, by connecting them in real-time to improve Safety, Efficiency and most importantly making the Project Delivery more predictable and rigorous. **Platform Features:**

- 3D Visualization
- People tracking
- Equipment tracking
- Risk management
- Material tracking
- Value tracker
- Rule engine

## FUNCTIONAL CONCEPT

### Solution Architecture for Intelligent Connected Construction Platform – Case: Petronas



### 3D – VISUALIZATION

The Dashboard includes immersive 3D visualization graphics of the construction site. On the 3D view (Digital Twin), all assets will be visible so the status of assets can be seen directly by clicking on the assets. Every single component is connected to the various subsystems, from various vendors. Data can be extracted from any component which is linked/associated with the field IoT device using various communication protocols. The 3D Digital Twin is interactive and spans all sites, helping to monitor the progress of many other ongoing projects. The Crew is monitored using the wireless tagged Input-output (IO) devices; in real-time, supervisors/engineering managers can view productive and non-productive zones.

3D visualization can be added with another dimension of project related information to make it 4D and ensure all vital details are available with a mouse-click. This will help in resolving any issue in pre-emptive/proactive manner instead of resolution at the eleventh hour, thus saving time and resources.

## **PEOPLE TRACKING**

From access control to construction activities, real-time tracking of people on-site is possible using IoT devices in permissible zones. The zone might have a certain crew pre-authorized to work; the monitoring solution also shows anyone present after the allotted shift time. Updated information on supervisor-crew coverage ratios, how many crew members and supervisors are onsite etc., is also available.

The platform logic i.e., rules engine, continuously tracks all work orders created as well as the escalations. The field crew will be notified from the central server by email and mobile messaging if any work is allotted. The solution is equipped with interactive graphical floor-by-floor navigation to track people allocation to productive zones.

Motion sensors and Bluetooth communication are the backbone of accurate indoor people monitoring for productivity enhancement. For instance, if a person is sitting idle, or does not move for more than five minutes, the supervisor immediately gets a notification.

Safety is critical. AVEVA NET includes proactive monitoring based on thresholds for alarms and alerts, so that working personnel are always informed on potential hazards or emerging incidents. The graphical interface can guide emergency movement to a safe zone.



## **RESOURCE MANAGEMENT**

The platform enables resource allocation with online tracking of equipment such as cranes, forklifts at the site. AVEVA NET also monitors asset condition proactively, and based on indicators, can alert on which equipment must be scheduled for preventive maintenance activity. In terms of work packages, it can show high-level progress and what packages are being used at the construction site. Detailed work packages are visualized on the screen, with progress shown at each level.

## **CONNECTIVITY AT SITE**

The asset-light IoT (Internet of Things) network module is used with LoRa technology for seamless, long-range communication and data transfer. This technology stack can transmit signals more than 10 km, However, there are other factors that will influence actual/realistic range - such as the network and node-gateway positioning, surrounding environment (presence of physical obstacles), antenna performance, Tx power mode, etc.

LoRa is just one of the many technology options that are interoperable with AVEVA NET and one can choose to deploy any protocol and equipment to suit specific needs.

## **KEY PERFORMANCE INDICATORS (KPIs)**

AVEVA NET embeds parameter-based monitoring intelligence to track critical real-time indicators such as safety compliance for both personnel and equipment on site, coverage ratio. The action element provides intervention options assigned to the user by role. The asset tracking module shows productive and non-productive zones, total deployed personnel vs. active, total equipment at a site that is active vs. inactive, and safety officers' coverage.

The sustainability parameters such as carbon footprint, emissions from use of fossil fuels, and other processes can be efficiently tracked.

Data export and visualization: Users can export the workers' industrial engineering data (Time and Motion studies) such as work progress, work time on-site, time from entry to production zone, time from productive zone to exit.

### **OPERATIONAL INTELLIGENCE VIA ANALYTICS**

The Intelligence layer in a Connected Construction platform must harness advanced techniques like Artificial Intelligence (Machine Learning) for:

- Predictive Analytics based on trends and business process algorithms,
- Prescriptive Advisories and Alerts based on personnel activity and equipment status in relation to external situations
- Root cause analysis. For instance, if the equipment at site is malfunctioning and that data could be logged in the respective system. The expert system captures the issues and identifies the potential root causes, to prescribe remediations.
- The Machine Learning feature enables the platform to evolve and self-train from the data and adapt to the project environment.

### **MANAGING MULTIPLE SITES**

This is an insight platform, the site-based visualization helps to manage multiple sites at the same time. The executives or Construction manager would like to see the overall status and issue of the site. This feature will come in handy when the critical stakeholders may or may not be visiting the site. The integration of CCTV, Drone cameras, Alerts, safety information. The auto generated action could be done using a Video analytics solution.



## **PROJECT MONITORING**

The project monitoring feature is completely user-defined, where we can configure the project plan, assets, contactors, internal team, etc. It includes an execution view to manage the projects and the construction progress and work breakdown structure of different sites, departments, contractors etc. It has the capability to view the progress of the remote sites.

## **OPTIMIZATION & SAFETY MANAGEMENT PLAN**

In construction safety management, it is a very necessary work to optimize the construction safety management measures by applying the specific process such as the preparation and optimization of the safety management plan, safety activity monitoring, early warning of safety hazards, and evaluation of overall safety work. There are problems in the traditional management mode, such as lack of predictions, poor overall controllability, and the overall work is more dependent on human factors. The optimization of safety education and training for the construction personnel could be replaced with VR technology. creating a realistic image of the three-dimensional construction scene, but also can deliberately set the corresponding safety hazards, strengthen the construction personnel's emotional awareness of safety accidents, so the personnel may build more intuitive sense of safety knowledge, improve the overall effectiveness of safety education activities. The Connected Construction can give more intuitive indications of possible safety hazards during actual construction and optimize the details of the construction plan things in advance to improve the overall level of safety management.

## **CONCLUSION:**

With the above details of the construction progress and safety management work, Connected Construction covers all aspects of the construction management.