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Online Inspection System, Data Acquisition and Processing For Fault Diagnostics Using Edge Analytics and Cloud Based Data Acquisition and Reporting System

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ABSTRACT

The cost of Data and its speed continue to follow a downward trajectory with the advent of 4G and 5G technologies. This coupled with the low cost of data storage offered by the cloud computing environment in the form of IAAS (Infrastructure as a Service) holistically provides an impetus towards making technology available for everyday use. Consider a consumer electronic equipment such as a washing machine. It contains sub systems such as Power Supply Board, Electronic control board interfaced with a number of sensors, buzzers, LCD, ADC and several other components such as Motors, relays and regulators which work in sync and perform the intended operation as a standalone device.

Providing tapping points or boundary scanning mechanism to gather data which are critical to the device functionality(such as Motor speed, its RPM, the voltage levels of the Power supply board, the sensor data, the data from the onboard controller)and introducing them to an embedded computing environment where they are analyzed onboard by an algorithm which performs edge analytics to make decisions based on the criticality of the parameter values provides a first level of defense in case of device deterioration.

The second and a more consistent approach would involve leveraging the connectivity of the embedded board on the device to a cloud computing environment through the World Wide Web. The service center accesses the individual devices present in their locality on their Web portal and can get real time information about the device performance, idle time, time for routine service check , the wear and tear undergone by an individual sub system in the device and can undertake a precautionary care by intimating the user to shut down the system in case a deviation from the normal behavior occurs thereby saving considerable amount of time and man hours spent on trouble shooting the problem. The User and the Service provider are thus in a Win all situation where in the user is exempted from being annoyed by making calls to the customer care and the Service Provider can monitor the device in real time and guarantee 100% user satisfaction.

Keywords: Cloud Computing, IAAS, Embedded Computing, Edge Analytics

I. INTRODUCTION

Data extraction from a digital device in order to get insights into the device functionality and gain competitive advantage is the new buzz word in the Industrial Internet of things But harnessing that data 'potential' from scratch isn't easy. Datasets can be fragmented and even siloed such that they can't be used elsewhere. Operational Technology (OT) and Information Technology (IT) often operate separately, leading to duplication. And, even though there are islands of excellence that meet various Key Performance Indicators (KPIs), opportunities may be missed if those KPIs are not standardized across the business.

Tapping into the power of a software platform can help companies get the answers they need when they need them to plan ahead and optimize performance. Industrial companies need a software platform that: is machine-centric, supports heterogeneous data acquisition, storage, management, integration, and access, provides advanced predictive analytics, guides personnel with intuitive user experiences, is delivered securely in the cloud. [1]

The idea is of interconnectivity inside IoT gadgets yearning the world where billions of items can detect, convey and share data, all interconnected over open or private Internet Protocol (IP) systems. The IoT can possibly convey arrangements that drastically enhance vitality, proficiency, security, wellbeing, instruction and numerous different parts of everyday life. These interconnected items have information consistently gathered, broken down and used to start the activity, giving an abundance of insight to monitor the health of devices. All connected nodes within IoT framework are gathering information and that could be prepared at a similar hub for security and effectiveness purposes. Aggregating the data close to its source in IoT is known as edge processing/edge analytics. [2]

Industrial IoT ecosystems that connect their machines, equipment, and production systems to the digital enterprise. The embedded systems technology will provide the intelligence "at the edge." In today's connected factories and plants, embedded systems provide the foundation for the next generation of smart connected IoT devices and the digital enterprise. These intelligent edge devices can aggregate and analyze sensor and other data and stream information to support predictive analytics platforms and the concept of the digital twin. Adding to this is the cloud model that allows businesses to take advantage of key capabilities, including: Lower costs based on the economics of a centrally managed and shared infrastructure. Scale to meet different business and application workloads by easily adjusting capacity on-demand, Generate actionable insights into device performance, Deliver insights from analytics that can be developed and run at all levels of the process.

II. METHODOLOGY

A. System Architecture

The system architecture of the proposed method is as shown in the figure (1).The aim is to address the issue being faced by electronics manufacturers in test strategies and to enable tests to be undertaken where no other technologies could gain access. The device or the machine is integrated to a high data rate sensor which is ubiquitous in the present scheme of Industrial internet of things (IIOT). Each sensor specific to the machine parameter is interfaced to a subsystem to read the analog parameter values. The devices may include a wind turbine, a motor used for pumping oil or natural gas , a consumer electronic component such as a Heavy duty washing machine, motor vehicle etc. The analog parameters for a motor include the Motor RPM, terminal voltage, torque constant, terminal resistance, terminal inductance, and load Inertia etc.

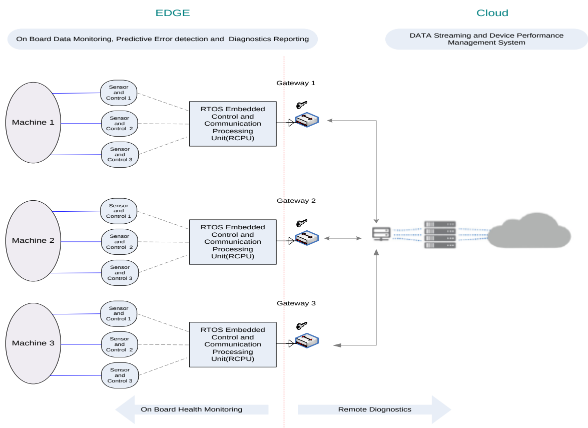

Figure 1. System Architecture

These raw parameters upon digitization by the sensor and control system are encoded and sent to the RTOS Embedded Control and Communication Processing Unit (RCPU). Similarly, the data from other subsystems are assigned to the I/O pins of the RCPU, which performs concurrent programming and the hardware description language in the embedded system instantiates the pins to the entity blocks so that the parallel processes can perform computation in real time and optimizes the functionality of the monitoring system.

A. Embedded Control and Communication Processing Unit (RCPU)

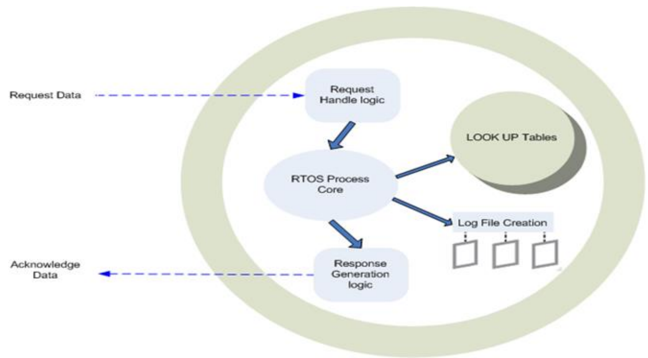

Figure 2. RCPU Core

The real time operating system in the RCPU ensures that the stream of data from the sensors are synthesized and interpolated to extract the performance parameters that are crucial to maximize the potential utilization of the resources. The operations in the System are synchronized with a common clock generation circuit using the PLL blocks in the core of the Field programmable gate arrays that from the heart of the RCPU.

The sensor data are used in not only to perform the Built in Self-test (BIST) but also to monitor the device performance. The intelligence of the edge algorithm ensures that the device performance is maintained at an optimal level and any deviation from the normal behaviour is assessed by determining the probabilistic distribution of error occurrence from the sensor output. If this happens, the RCPU then decides to shut down the system before logging the data from the sensors. This way of performing the boundary scanning not only enhances the efficiency of the every sub modules in the device but also holistically provides the information of every single module on a need to know basis when the RCPU provided with connectivity to the cloud computing environment.

B. Representational State Transfer (Rest) API's For Analysis in The Cloud

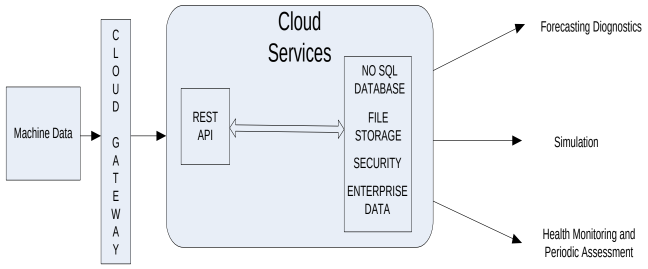

Figure 3. Representational Data Transfer (REST) API's for analysis in the Cloud

The figure 3 shows the representation of Interconnection between the cloud and the API's that form the core of the Online diagnostic system. With the availability of the open source PAAS platforms such as the Cloud Fundry, which provides the development frameworks and application services, the deployment of the Representational State Transfer(REST) API's in the cloud provides the flexibility to suit the device requirement as the data are continuously streamed from various locations. The RESTful web service is a collection of open protocols and standards used for exchanging data between applications or systems. The platforms can use web services to exchange data over networks in a manner similar to inter-process communication. The API can communicate to and from the edge devices and the data obtained are stacked by creating a NOSQL data base to maintain the record of the device characteristics .The deployment of the API's on the stored data provides the means to gather and analyze the data and do the remote monitoring and diagnostic checks.

III. CONCLUSION

As embedded systems enable intelligent edge devices for machines, equipment, and production systems, cyber security is a critical factor in software and hardware development. The secure gateway and the connectivity to the cloud must be reliable and the data that is propagated are stored in the structured data base where in multiple data set from various other devices from a common geographical location are reduced and a unified portal is used as a platform to analyze the data The data repository enables simulation of the results and optimizes the performance of the device and creates a digital twin of the machine. The efficiency of the system lies in the connectivity of the host to the network and the reliability with which the data decimation takes place from the source to the destination. The algorithm at the source to perform edge analytics and flexibility at the cloud to update and upgrade the software resources to enable mobility to deploy machine apps must be robust. This will be an enabler to a new generation of social and interoperable products.

IV. ACKNOWLEDGEMENT

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V. REFERENCES

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