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Iot- A Technology Transfer in Manufacturing Future Products

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***Abstract:** Manufacturing field is facing more challenges than ever before, so it needs technology transfer and advancement which can ensure its relevance in a competitive global context and can promote continual improvement. Proactive action becomes an automatic process in the context of business sustainability. One of the most recent changes in the manufacturing field is the paradigm shift from traditional mechanical systems to software-driven ones. In this context, Internet of Things (IoT) provides plenty of opportunities to pioneer new products and influence interconnected systems with immeasurable scalability. IoT-driven intelligent devices that are capable of communicating with the manufacturer once they have left the production line is very much required in the present scenario. As a result, manufacturing engineers have to take into considerations of various aspects when designing their products such as software-driven controls, remote product assessment and updates, automatic product improvements which needs multitude of sensors.*

So Engineers are uniquely positioned to steer the course of innovation by embracing IoT, which will leads to the development of smart products. The paper provides an insight into how these possibilities can be achieved in the manufacturing field so that it will enable the organizations to demonstrate themselves in leveraging the maximum potential and developing the smarts products in terms of significant investments in monitoring, measuring and analyzing product performance, earnings stability, research culture, industry engagement and accountability to society in meeting their needs. This paper proposes a new model based solution in the area of manufacturing industry by making use of ability of IIoT and cloud computing services.

Keywords: Smart Products, Industrial IoT, Scalable IoT

I. INTRODUCTION

Internet of Things (IoT) plays an important role in the digital transformation of manufacturing industry. With its adoption, a new terminology originated as Industrial Internet of Things (IIoT) , capable to provide valuable insights about the efficiency of manufacturing operation by processing critical production data and making use of Cloud computing services. It could be anything from a sensor embedded on an assembly line to cloud computing services for various requirements. More specifically, the engineers will be responsible for developing hardware that can operate in more challenging situations than traditional computing devices and also receive regular software updates without breaking down which ensures seamless interactions between hardware. IoT has modernized the way products are designed, manufactured and improved. IoT also provides collaborative working environment for engineers of various disciplines. But most of the products are still realized in the physical world. IoT simply helps manufacturers make more meaningful changes faster and far more cost-effectively. According to a report published by **Fortune Business Insights™**, the global IoT in Manufacturing Market size is projected to reach **USD 136.83 billion by 2026**. Driven by the growing popularity and widespread applications of IoT in manufacturing industry, the market will rise at a staggering **22.1% CAGR** during the forecast period [15].

II. NEED AND CHALLENGES

This section focuses on the IIoT applications need and its challenges in the manufacturing industry.

A. Need

i) Remote management of factory Units

Digital connectivity of factory units through IoT enables remote management of factory units, process automation and optimization.

ii) Automatic updation and maintenance of hardware units

IoT Sensors can actively monitor the strength of material used in any machinery by assessing the working environment thereby facilitating the manufactures to conserve energy, reduce cost, increase operation efficiency by reducing the downtime and also raise maintenance alerts and automatic updation.

iii) cross-channel visibility in inventory management

With the use of IoT applications, supply chain monitoring and inventory tracking will be easier and can provide realistic estimates of the available material, work in progress and estimated the arrival time of new materials thereby optimizing supply and reduces shared costs in the value chain.

iv) Safety and Security

Effective monitoring of the Key Performance Indicators (KPIs) of health and safety such as the number of injuries and illness rates, short- and long-term absences etc,. Lagging indicators can be addressed elated to health and safety issues.

v) Quality Control

The data collected by IoT sensors on various stages of product cycle can be analyzed to identify issues related to quality and can take actions.

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Also with the usage of IoT in final product, the data related to user experience can also be collected.

vi) Investing in Smart Sensors

Companies have to carefully prioritize their organizational goals and business objectives and should consider investing in smart sensors to increase value capture through their supply chains.

B. Challenges

i) Security issues through outdated hardware and software

Regular updates for hardware and software is essential to protect the devices from vulnerable to attacks.

Most of the time, it is not happening. Another problem associated with security aspects is providing consumers with default credentials.

ii) Predicting vulnerabilities and preventing them

Since the cyber attackers try with various permutations, to predict the vulnerabilities are difficult. But with the application of Artificial intelligence and the usage of analytical tools, also cloud services with threat intelligence; it is possible to some extent. It is also difficult to monitor and fix it and IoT device needs various apps, services, and protocols for communication.

iii) Data protection

The challenges associated with data protection can happen in many mays:

One way may be due to the reason that because it gets transferred between multiple devices within a few seconds. Another can be due to data leak during its transmission through the internet. Even many the service providers might not be compliant with regulations and laws.

iv) Security of IoT based vehicles

Vehicles that make use of IoT services can be hijacked from remote locations, leads to the safety and security of commuters.

III. RELATED WORK

This section provides an insight on related works in the area of study.

There exists structural health monitoring platform embedded with to estimate the size and location of structural damage and upload the data to Internet which can be stored and checked remotely from any mobile device [1].A combination of pulse-echo and pitch-catch techniques are used to determine presence of damage and to determine location of the damage [1].Laser Doppler velocity meter can be used in the detection of noncontact and low frequency lamb-wave for structural monitoring[2]. The detection can be made more robust by using a triaxis, multiposition scanning laser vibrometer [3].

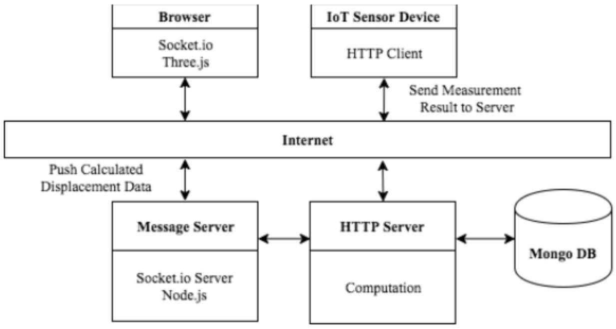

Fig. 1.Software architecture of real-time Health monitoing system[4].

In the architecture shown in figure 1, there are two kinds of servers: one is the regular HTTP server that does all the computations, interacts between user's browsers and itself and a real-time message server ,pushes the computed monitoring results received from HTTP server to user's browser. The model fails to detect local damage detection[1].

In the past decade, many studies have conducted to extend the centralized cloud computing with Fog and Edge Computing. Geo-distributed cloud computing model proposed in [8-9] makes point to make use of the data centres associated with edge computing. Further solution is proposed with mobile cloud computing model. Industry-led fog computing architecture was first introduced by Cisco research [10] was also a promising solution in this area.

IV. PROPOSED MODEL

The proposed model leverages the layered architecture of cloud computing along with the capability of Cloud computing's storage, processing and service ability, combined with the IoT's ability of information collection. The proposed model Starting from the lowermost layer, Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS) and Data as a Service (DaaS) Data is one of the most important components of this stack and providing data as service has a huge potential, especially to the geospatial world. It is less talked about compared to the above mentioned layers. Sensors as Services can be the new paradigm which can be added with the existing Cloud services.

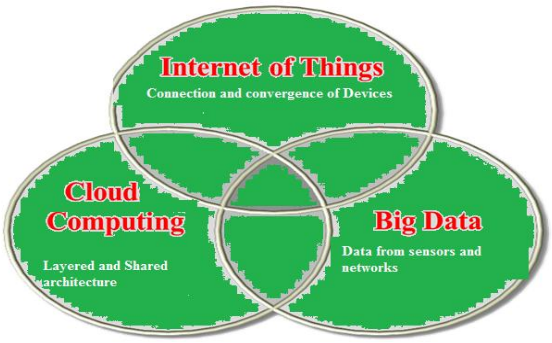

Fig.2. Integration of new challenges

Table- I: Cloud Vs. IoT Vs. Big data

Cloud	IoT	Big Data
• Plasticity of resource allocation • Intelligent applications • Energy saving • No on-site infrastructure • Heterogeneity of environment • Scalability and agility • Virtualization	• objects move freely changing access technologies • Geographical distribution	• high-volume, high-velocity and high-variety

A. Methodology

Two approaches can be followed:

1. Cloud centric IoT

This approach brings IoT data into Cloud computing. This approach facilitates dense geographical distribution of objects and devices.

To be successful, IoT requires the support of Cloud to store, transmit, and infer intelligence from the large volume of data available with the capability of extended scalability.

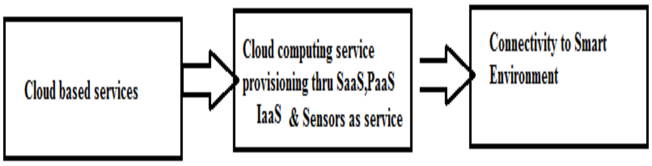

Fig.3. Block diagram for Cloud centric IoT

Advantages:

- Resource elasticity and scalability
- Cost effective ness
- Rapid speed and agility in deploying products and solutions
- Higher reliability, availability and security at scale

2. IoT Centric Cloud Computing

In IoT centric Cloud computing, Edge computing can function as an infrastructure level technology to facilitate the process of data collection and analysis where it is created.

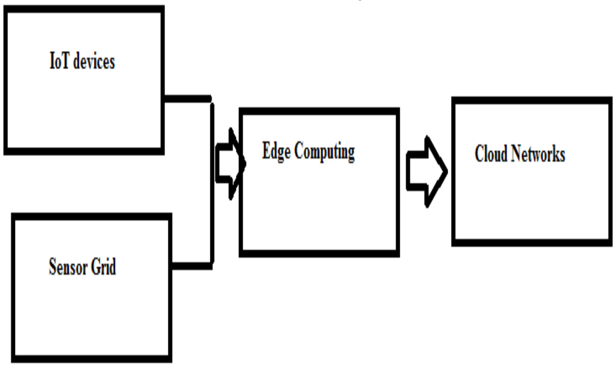

Fig.4. Block diagram for IoT Cloud

Advantages:

- IoT Cloud Controller and link to Sensor Services
- Distributed Access to Sensors and services driven by sensor data
- Natural collaboration
- Reduced load on network, reduced data exposure, zero latency, data management with less cost & energy efficiency with edge computing

B. Industry Applications of IoT with edge computing

1. **Manufacturing** - Enhances efficiency, real-time monitoring and diagnostics, machine learning, and operations optimization. Also enables automated feedback loops and predictive maintenance for maximizing the uptime and lifespan of equipment and assembly lines.

2. **Oil and gas extraction** - provides proactive monitoring and protection against equipment failure and environmental damage, onsite delivery of advanced analytics and enables real-time responses required to ensure maximum production and safety.

3. **Mining Sector** – provides real-time operations, onsite monitoring and diagnostics, alarm management, and predictive maintenance to maximize safety, operational efficiency and minimized downtime in less cost

4. **Healthcare Sector**- By processing and analyzing more data at where it is produced, medical facilities can optimize supply chain operations and enhance patient services and privacy in a cost effective manner

5. **Retail Shopping** - Enrich the user experience by delivering real-time channel personalization and supply chain optimization. It also enables higher levels of personalization and security.

6. **Smart Buildings** – Provides lower energy consumption, better security, increased occupant comfort and safety, and better utilization of building assets and services with reduced bandwidth costs and latency.

C. Proposed Model for IoT Cloud with edge Computing

The proposed model is a layered architecture.
Bottom layer – Sensor Grid and IoT devices, responsible for production and consumption of data
Middle layer – Edge Computing nodes, responsible for Computing operations
Top Layer – Cloud Networks, responsible for data analysis & visualization

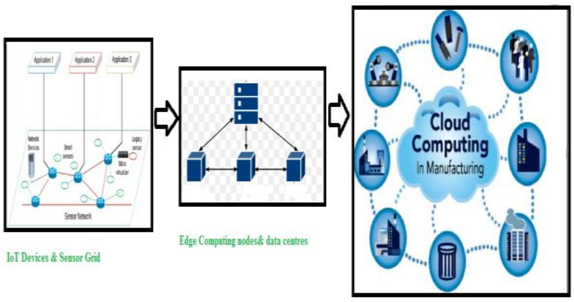

Fig.5 Proposed Model of IoT integrated with Edge computing

The role of an edge computing is to provide multiple accesses to the heterogeneous IoT devices/sensors and finally deliver the data to destination cloud networks. In the proposed model, Edge computing node provides downside connectivity to IoT sensors and devices and upside connectivity to cloud networks. Also, the model provides the function of data storage, processing and analysing and additional function of intelligence.

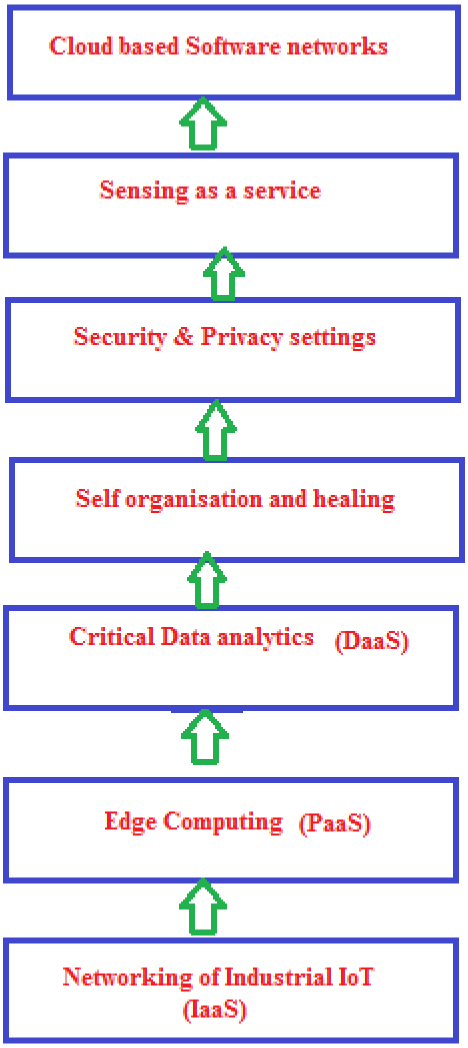

Fig.6 Software Architecture solution for IoT Systems

By exploiting the architectural solution model provided in fig.6, complexities of implementation and configuration of the IoT systems can be minimized. In addition to that, the things and their interconnections in IoTs can be mapped to architectural components and connectors to effectively develop, deploy, and maintain IoT systems.

D. Technological hindrance in developing Smart Products

In order to investigate innovation impacts and to derive management measures, few Paradigm changes have to be adopted; these paradigms will trigger innovations such as remote product assessment and updates, automatic product improvements etc.

Missing solutions for module management as well as the diversity of variants and versions were considered as innovation inhibitors.

Innovations are new products or product changes, involves information from various phases of product development starting from requirement gathering phase to delivery phase. Changes in one phase will show impacts on other phases or disciplines. Changes were driven by the changes of the information technology (IT), which includes software engineering, communication technology and industrial engineering.

V. RESULTS AND DISCUSSION

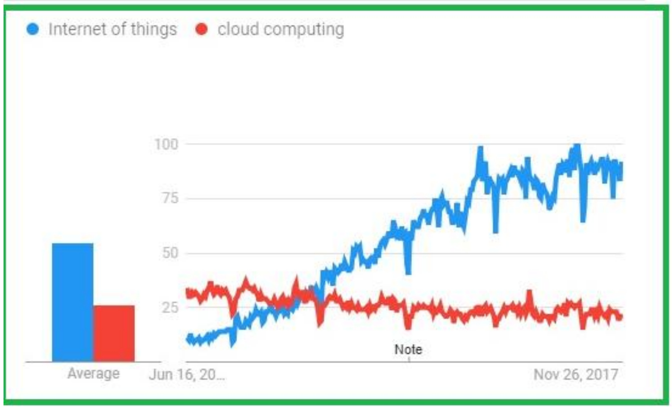

Fig.7 Comparison of IoT and Cloud Computing past 5 years [16].

Table- II: Key Paradigm shift indicators

Key required paradigm changes	Key change driven factors identified
Modularization	Interdisciplinary dependencies
Tool chain change such as changing a tool, inserting a tool, using interdisciplinary tool	Automatic compatibility
	Customer need for devices with potential
	Technology advancements
	Market competition
	Predictive maintenance
	Availability
	Security
	Cost

The following steps can be followed to achieve predictive maintenance as part of self-organisation and healing of developed products.

Step 1: Deploy sensors for machine health monitoring

Step2: Gather data & send to Expert system for health prediction

Step3: Condition assessment and recommended action

VI. CONCLUSION

This paper is written by conducting interviews with experts from the machine and manufacturing industry, in order to identify and specify relevant innovation triggers and inhibitors. Based on the interview results, conclusions are made and a proposed a model which can enable dynamic updation in the developed systems with the help of embedded sensor software in the sensor Grid. Future work has to focus on how to control the impacts of the innovation triggers and to eliminate inhibitors.

The edges for IoT in manufacturing sector are well placed to manage the required infrastructure and integrate it into their own existing networks.

Mobile networks are also suited to IoT edge, as they are highly distributed and the basis for many IoT deployments which facilitates both high quality connectivity with fast data processing. AI driven automation, enabling the next generation of IoT services in manufacturing sector is expected to meet the automatic updation of once manufactured and delivered products.

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