Dr . SNS RAJALAKSHMI COLLEGE OF ARTS AND SCIENCE
COIMBATORE

DEVELOPING INDUSTRIAL IoT

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SYLLABUS

UNIT – 01 : INTRODUCTION TO IoT

Definition - Market Size - IoT v IoT Scope - History - Vertical and Business Process areas - Leading companies - Importance of building Ecosystems - IoT Value Chain – who does what? IOT Platform, Interfaces, API, clouds, Data Management Analytics, Mining &Manipulation; Role of IOT in Manufacturing Processes Use of IOT in plant maintenance practices, Sustainability through Business excellence tools Challenges & Benefits in implementing IOT.

UNIT – 02 : ARCHITECTURES

Overview of IOT components; Various Architectures of IOT and IIOT, Advantages &disadvantages, Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT.

UNIT – 03 : SENSOR AND INTERFACING

Introduction to sensors. Transducers, Classification, Roles of sensors in IOT, Various types of sensors, Design of sensors, sensor architecture, special requirements for IOT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACNET, Current, M2M.

UNIT – 04 : PROTOCOLS AND CLOUD NEED OF PROTOCOLS

Types of Protocols, Wi-Fi, Wi-Fi direct, Zigbee, Z wave, BACNET, BLE, Modbus, SPI, I2C, IOT protocols –COAP, MQTT,6lowpan, lwm2m, AMPQ IIOT cloud platforms: Overview of cots cloud platforms, Predix, thing works, azure etc. Data analytics, cloud services, Business models: Saas, Paas, Iaas.

UNIT – 05 : PRIVACY, SECURITY AND GOVERNANCE

Introduction to web security, Conventional web technology and relationship with IIOT, Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, Analytics and Applications Role of Analytics in IOT, Data visualization Techniques Internet of Things Applications : Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IOT in Manufacturing Sector.

TEXT BOOK:

Daniel Minoli , "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications 2. Bernd Scholz-Reiter, Florian.

REFERENCE BOOK:

1) Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642-19156-5 e- ISBN 978-3-642-19157-2, Springer.
2) Hakima Chaouchi, "The Internet of Things Connecting Objects to the Web" ISBN: 978-1-84821-140-7, Willy Publications
3) Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2 nd Edition, Willy Publications.

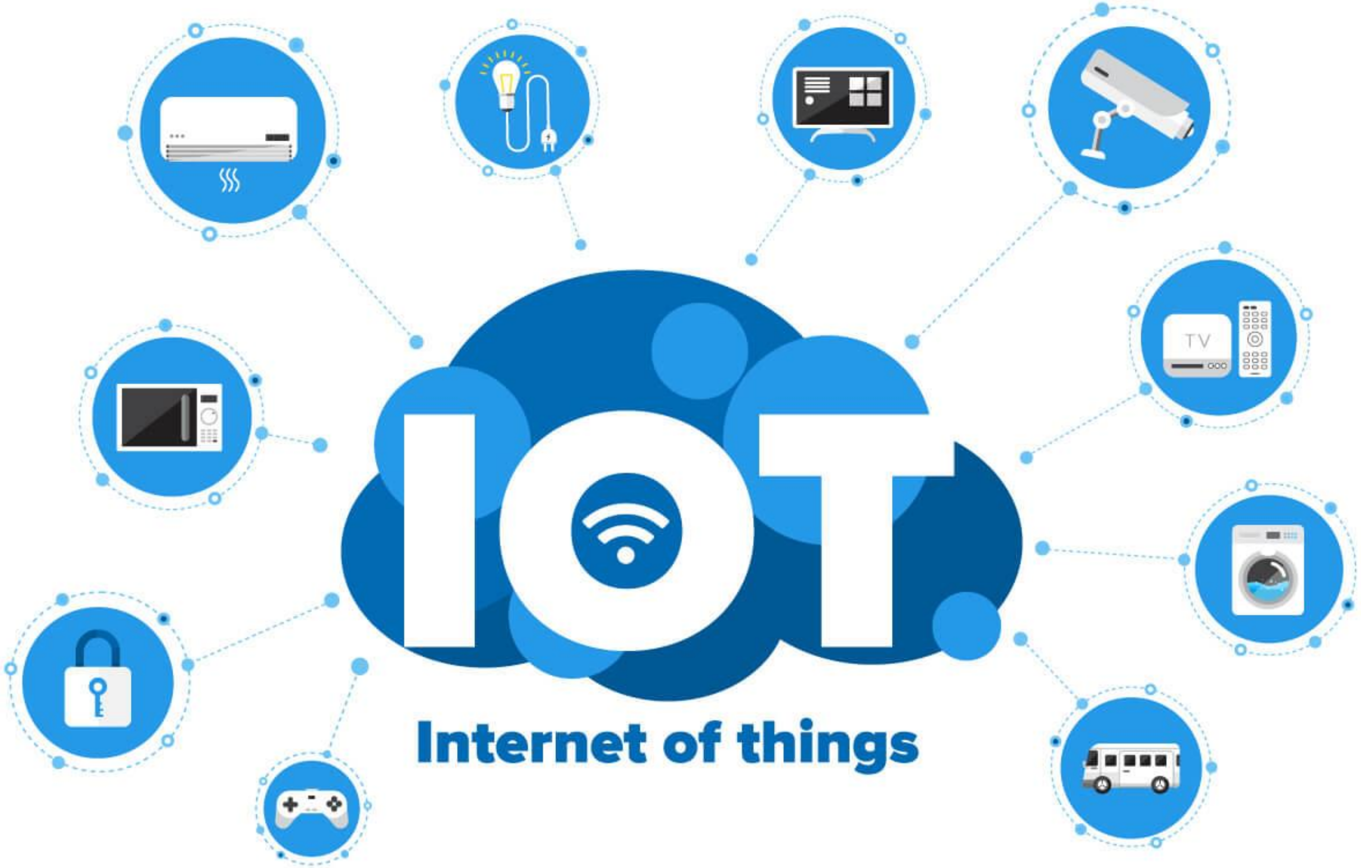
UNIT – 01: INTRODUCTION TO IoT

DEFINITION:

The Internet of Things (IoT) is a network of interconnected devices or "things" that communicate and share data with each other through the internet, enabling them to collect, exchange, and act upon information to enhance efficiency and functionality.

KEY COMPONENTS OF IoT:

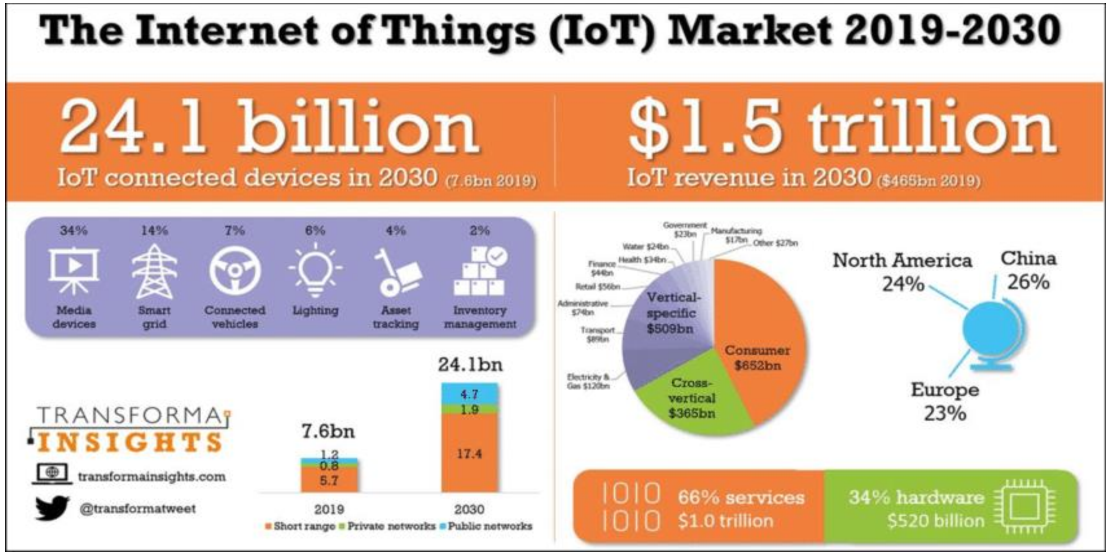
1) Devices/Things
2) Sensors and Actuators
3) Connectivity
4) Data Processing
5) Cloud Computing
6) Edge Computing
7) IoT Gateways
8) Security
9) User Interface



Market Size in IoT:

As of my last knowledge update in January 2022, the market size for the Internet of Things (IoT) was substantial and experiencing continuous growth.

In general terms, the global IoT market size was estimated to be in the range of tens to hundreds of billions of dollars, and projections suggested that it would continue to expand as more devices became connected and new applications emerged.

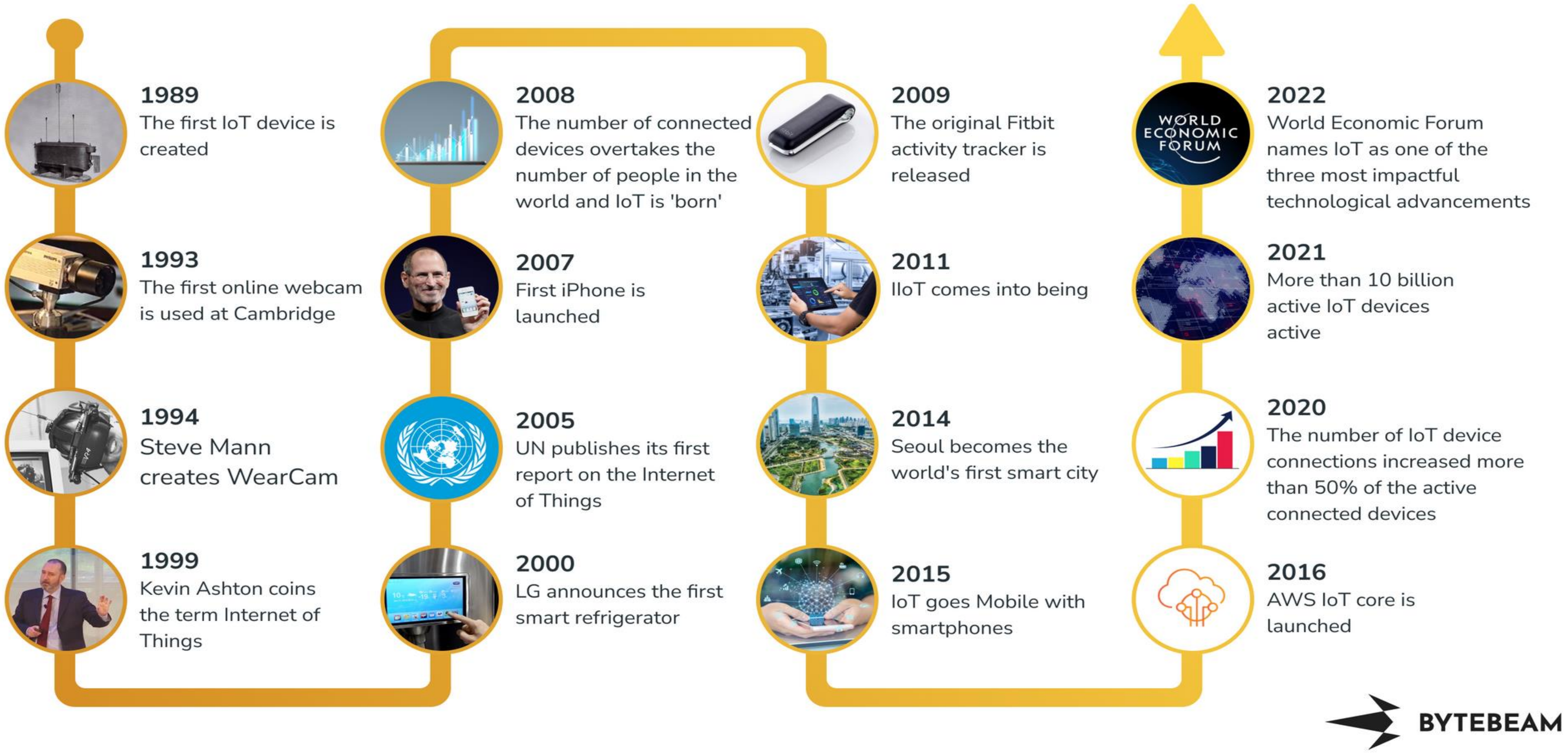


IOT V/S IIOT THINGS:

The terms "IoT" (Internet of Things) and "IIoT" (Industrial Internet of Things) are related concepts, but they differ in their scope and application. Here's a brief overview of each:

IOT	IIOT
Scope: IoT refers to a broad ecosystem of connected devices and objects that communicate with each other through the internet. These devices can be found in various contexts, including homes, cities, healthcare, agriculture, and consumer electronics.	**Scope:** IIoT specifically focuses on the use of IoT technologies in industrial settings, such as manufacturing, energy, transportation, and other sectors. It involves connecting industrial equipment, sensors, and devices to improve operational efficiency and decision-making.
Application: IoT encompasses a wide range of applications, such as smart homes, wearable devices, connected vehicles, and various consumer gadgets. The primary focus is on enhancing convenience, efficiency, and automation in daily life.	**Application:** IIoT applications include predictive maintenance of machinery, real-time monitoring of industrial processes, supply chain optimization, and overall improvements in production workflows. The goal is to enhance productivity, reduce downtime, and optimize resource utilization in industrial environments.

HISTORY OF IoT:



VERTICAL AND BUSINESS PROCESS AREAS IN IoT:

1**) Manufacturing (Industrial IoT - IIoT):**
•**Processes:** IoT is used for real-time monitoring of machinery, predictive maintenance, supply chain optimization, and improving overall operational efficiency in manufacturing plants.
•**Benefits:** Reduced downtime, increased productivity, and improved quality control.

2) Healthcare (IoT in Healthcare):
•**Processes:** Remote patient monitoring, asset tracking, inventory management, and the integration of wearable devices for health tracking and management.
•**Benefits:** Improved patient outcomes, optimized resource utilization, and enhanced healthcare delivery.

3) **Agriculture (Precision Agriculture):**
•**Processes:** IoT sensors monitor soil conditions, crop health, and weather patterns. Automated equipment and drones are used for precision farming.
•**Benefits:** Increased crop yield, resource efficiency, and data-driven decision-making for farmers.

4) **Smart Cities:**
•**Processes:** IoT is applied to urban infrastructure for smart parking, waste management, traffic monitoring, and environmental monitoring.
•**Benefits:** Improved city planning, reduced congestion, and enhanced sustainability.

5) Transportation and Logistics (IoT in Logistics):
•**Processes:** Fleet management, asset tracking, predictive maintenance for vehicles, and supply chain optimization using IoT technologies.
•**Benefits:** Increased operational efficiency, reduced fuel consumption, and improved logistics management.

6) Retail (IoT in Retail):
•**Processes:** Inventory management, supply chain optimization, and personalized customer experiences using IoT-enabled devices.
•**Benefits:** Enhanced customer engagement, reduced stockouts, and improved supply chain visibility.

7) Energy (Smart Grids):
•**Processes**: IoT is applied to monitor and control energy consumption, optimize grid performance, and enable smart meters.
•**Benefits:** Improved energy efficiency, reduced costs, and enhanced grid reliability.

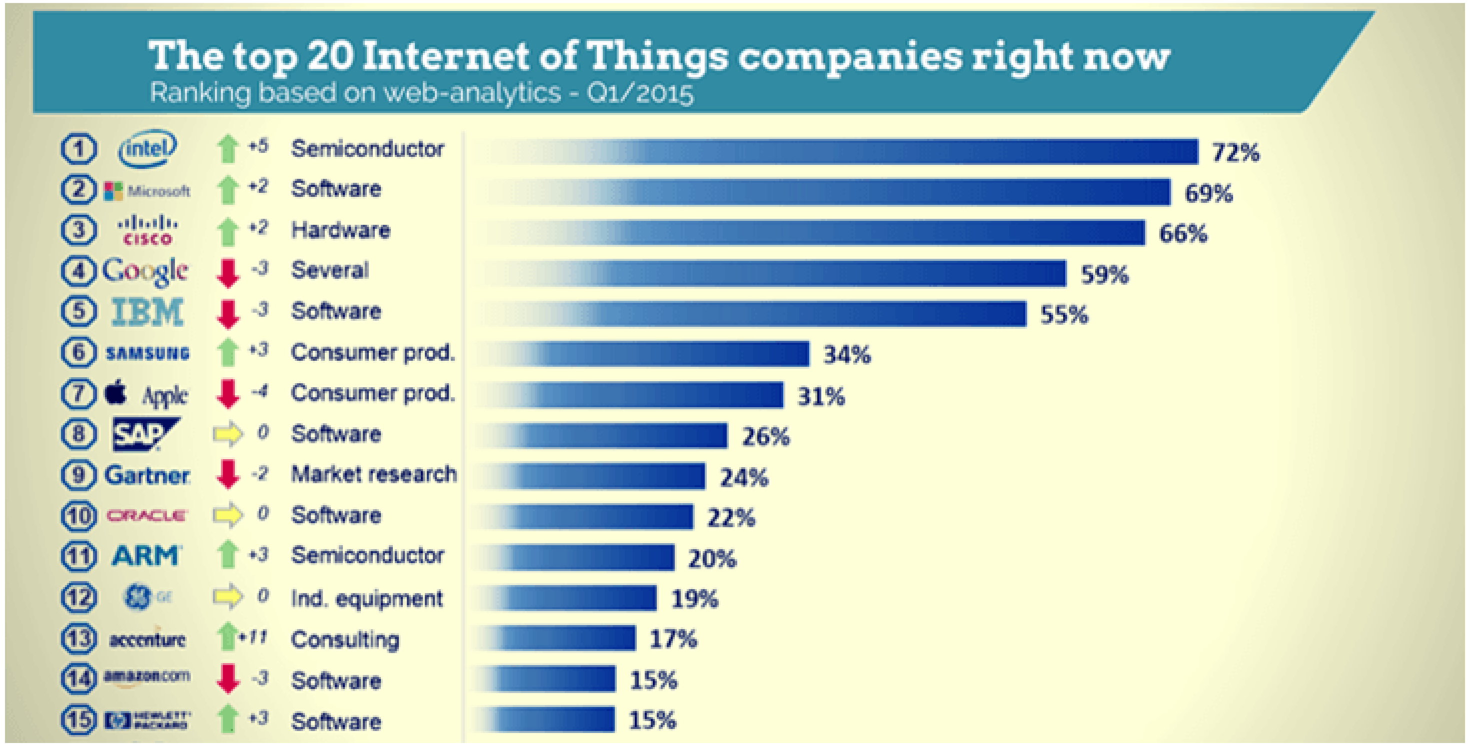
8) Environmental Monitoring:
•**Processes:** IoT sensors are used for monitoring air and water quality, wildlife tracking, and climate data collection.
•**Benefits:** Early detection of environmental issues, improved conservation efforts, and better understanding of ecological systems.

9) Smart Buildings:
•**Processes:** IoT is used for building automation, energy management, and occupancy monitoring.
•**Benefits:** Increased energy efficiency, improved occupant comfort, and optimized building operations.

10) Insurance (IoT in Insurance):
•**Processes:** IoT devices such as telematics in vehicles and smart home devices are used for risk assessment and personalized insurance policies.
•**Benefits:** Improved risk modeling, personalized pricing, and enhanced customer engagement.

LEADING COMPANIES IN IoT:

As of my last knowledge update in January 2022, several companies were prominent players in the Internet of Things (IoT) industry, each contributing to different aspects of IoT technology and solutions. Keep in mind that the competitive landscape may have changed since then. Here are some leading companies in the IoT space:



1.Intel Corporation:

Known for providing hardware solutions, processors, and connectivity solutions for IoT devices.

2.Cisco Systems:

Offers networking solutions, including IoT networking infrastructure and security for connected devices.

3.IBM:

Provides IoT platforms and solutions for data analytics, artificial intelligence (AI), and cloud services.

4.Microsoft:

Offers Azure IoT services, cloud solutions, and software platforms for IoT device management and analytics.

5.Siemens:

Known for its industrial IoT solutions, including automation, manufacturing, and smart infrastructure technologies.

6.General Electric (GE):

Offers Industrial Internet of Things (IIoT) solutions, especially in areas like energy, healthcare, and manufacturing.

7.Google (Alphabet Inc.):

Provides IoT solutions through Google Cloud Platform, including data analytics, machine learning, and cloud services.

8.Amazon Web Services (AWS):

Offers IoT services through AWS IoT, providing cloud-based solutions for device management, data storage, and analytics.

9.Qualcomm:

Known for its contributions to IoT connectivity, semiconductor solutions, and wireless technologies.

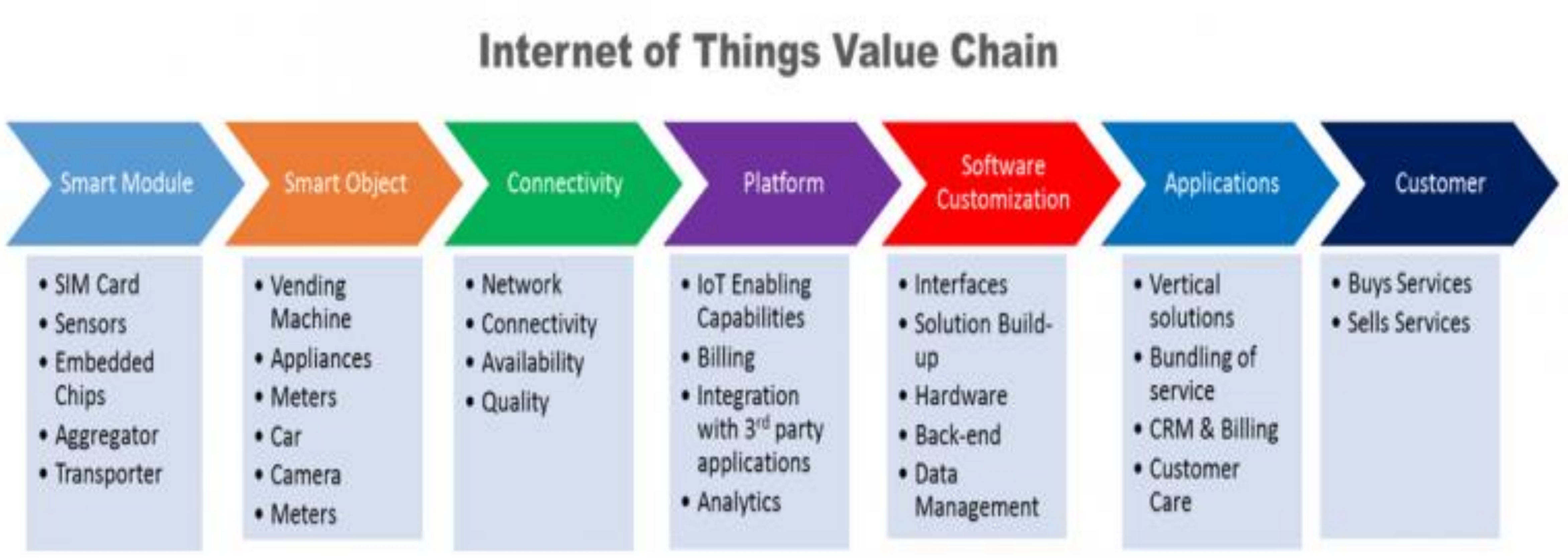
10. **Bosch:**
 Offers a range of IoT solutions, including sensors, software, and services for smart homes, cities, and industries.
11. **ABB:**
 Specializes in industrial automation and robotics, offering IoT solutions for smart factories and energy management.
12. **Honeywell:**
 Provides IoT solutions for various industries, including aerospace, buildings, and industrial process control.
13. **Huawei:**
 Offers IoT solutions, including connectivity, devices, and platforms for smart cities, agriculture, and more.
14. **PTC:**
 Known for its Thing Worx platform, providing IoT solutions for industrial applications, including manufacturing and maintenance.
15. **Oracle:**
 Offers IoT applications and cloud services for various industries, including supply chain, asset management, and connected devices.

IMPORTANCE OF BUILDING ECOSYSTEMS:

1) Interoperability and Compatibility
2) Data Integration and Analysis
3) Scalability
4) Improved Efficiency and Automation
5) Enhanced User Experience
6) Innovation and Collaboration

7) Cost Savings
8) Security and Standardization
9) Environmental Sustainability
10) Business Model Innovation

IoT VALUE CHAIN:



IoT PLATFORM, INTERFACES, API, CLOUDS, DATA MANAGEMENT ANALYTICS, MINING &MANIPULATION:

1) IoT Platforms:

•**Definition:** IoT platforms are software suites that facilitate the development, deployment, and management of IoT applications. They often provide functionalities such as device management, data processing, connectivity, and application enablement.

•**Key Features:**

- Device Management: Register, authenticate, and manage IoT devices.
- Connectivity: Support for various communication protocols.
- Data Storage: Store and retrieve data generated by IoT devices.
- Security: Implement security measures for data and device integrity.
- Application Enablement: Tools for developing and deploying IoT applications.

2) Interfaces:

•**Definition:** Interfaces in IoT refer to the points of interaction between different components of the IoT ecosystem, including human-machine interfaces (HMI) and machine-to-machine interfaces.

•**Examples:**

- **Human-Machine Interface (HMI):** Graphical interfaces allowing users to interact with and monitor IoT devices and systems.
- **Machine-to-Machine Interface:** Communication protocols and APIs enabling devices to interact with each other.

3) APIs (Application Programming Interfaces):

•**Definition:** APIs define how different software components should interact. In IoT, APIs enable communication between devices, applications, and services.

•**Examples:**

- **Device APIs:** Allow developers to interact with and control IoT devices.
- **Cloud APIs:** Facilitate data exchange between IoT devices and cloud platforms.
- **Web APIs:** Enable communication between web applications and IoT devices.

4) Cloud Computing:

•**Definition:** Cloud computing involves delivering computing services over the internet. In IoT, cloud platforms play a central role in storing, processing, and analyzing data generated by connected devices.

•**Key Aspects:**

- **Scalability:** Ability to scale resources based on demand.
- **Storage:** Cloud platforms provide data storage solutions.
- **Compute Power:** Processing capabilities for data analytics.
- **Accessibility:** Remote access to resources and services.

5) Data Management:

•**Definition:** Data management involves the storage, retrieval, and manipulation of data generated by IoT devices.

•**Key Aspects:**

- **Data Storage:** Storing and organizing large volumes of IoT-generated data.
- **Data Retrieval:** Efficient retrieval of relevant data for analysis.
- **Data Security:** Ensuring the integrity and confidentiality of IoT data.
- **Data Lifecycle Management:** Handling data from creation to disposal.

6) Analytics:

1. **Definition:** Analytics involves the interpretation of data to extract meaningful insights. In IoT, analytics can provide valuable information about device performance, user behavior, and more.
2. **Types:**
    1. **Descriptive Analytics:** Summarizes historical data.
    2. **Predictive Analytics:** Forecasts future trends.
    3. **Prescriptive Analytics:** Recommends actions based on analysis.

7) Data Mining & Manipulation:

1. **Definition:** Data mining involves discovering patterns and trends in large datasets, while data manipulation refers to the process of transforming and cleaning data for analysis.
2. **Techniques:**
    1. **Machine Learning:** Algorithms for predictive analysis.
    2. **Data Cleaning:** Removing inconsistencies and errors.
    3. **Data Transformation:** Converting data into a suitable format for analysis.

ROLE OF IIOT IN MANUFACTURING PROCESSES USE OF IIOT IN PLANT MAINTENANCE PRACTICES:

The Industrial Internet of Things (IIoT) is revolutionizing the manufacturing landscape, weaving its way into every stage of the production process and driving significant improvements in efficiency, quality, and agility. By connecting machines, sensors, and people through a network of intelligent devices, IIoT unlocks a treasure trove of real-time data and insights that empower manufacturers to optimize their operations like never before.

1. Data Collection and Monitoring:

IIoT enables the gathering of real-time data from sensors, equipment, and devices throughout the manufacturing plant. This data includes machine performance, temperature, humidity, energy usage, and more. Analyzing this data helps in predictive maintenance, identifying inefficiencies, and optimizing processes.

2. Predictive Maintenance:

By continuously monitoring equipment through IIoT sensors, manufacturers can predict when machinery might fail or require maintenance. This proactive approach minimizes downtime, reduces costs, and extends the lifespan of equipment.

3. Process Optimization:

IIoT allows for precise control and optimization of manufacturing processes. Through data analytics and machine learning, manufacturers can fine-tune operations to improve efficiency, reduce waste, and enhance product quality.

4. Supply Chain Management:

IIoT facilitates better visibility and transparency across the supply chain. It helps in tracking inventory levels, monitoring shipments, and optimizing logistics, leading to streamlined operations and reduced inventory costs.

5. Safety and Risk Management:

IIoT enhances workplace safety by monitoring environmental factors and ensuring compliance with safety protocols. It can alert workers to potential hazards and help in implementing preventive measures to minimize risks.

6. Customization and Agile Manufacturing:

With IIoT, manufacturers can respond quickly to changing market demands by enabling agile production. Customization becomes easier as data-driven insights allow for more flexible and responsive manufacturing processes.

7. Energy Efficiency:

IIoT aids in optimizing energy usage by identifying areas where energy is being wasted and suggesting ways to reduce consumption. This not only lowers costs but also contributes to sustainability efforts.

8. Quality Control:

Real-time data from sensors helps in continuous quality monitoring. Manufacturers can identify defects or deviations from set standards promptly, ensuring higher product quality and reducing waste.

USE OF IIOT IN PLANT MAINTENANCE PRACTICES, SUSTAINABILITY THROUGH BUSINESS EXCELLENCE TOOLS:

Predictive Maintenance:

- IIoT sensors collect real-time data from machinery and equipment, enabling predictive maintenance.
- Business excellence tools like Six Sigma or Total Productive Maintenance (TPM) integrate IIoT data for predictive analytics.
- This proactive approach minimizes unplanned downtime, reduces maintenance costs, and prolongs equipment life.

Condition-Based Monitoring:

- IIoT facilitates continuous monitoring of equipment conditions, allowing for condition-based maintenance practices.
- Tools like Lean Manufacturing combined with IIoT data help in identifying and addressing potential issues before they lead to failures.

Energy Efficiency:

- IIoT sensors track energy consumption patterns and inefficiencies in machinery.
- Business excellence tools like ISO 50001 (Energy Management Systems) utilize IIoT data to optimize energy usage, reducing costs and environmental impact.

Root Cause Analysis:

- IIoT data, when integrated with tools like Root Cause Analysis (RCA), aids in identifying underlying issues leading to equipment failures or inefficiencies.
- This helps in addressing fundamental problems rather than just treating symptoms, improving overall reliability and sustainability.

Continuous Improvement:

- Business excellence methodologies such as Kaizen or Lean Six Sigma, when coupled with IIoT insights, drive continuous improvement initiatives.
- IIoT data provides a foundation for data-driven decision-making, fostering a culture of ongoing improvement in maintenance practices.

Environmental Impact:

- IIoT-enabled data collection assists in monitoring and reducing environmental impact through tools like Environmental Management Systems (EMS).
- Sustainability practices are enhanced by leveraging IIoT insights to minimize waste, optimize resource utilization, and adhere to environmental standards.

Safety and Compliance:

- IIoT sensors contribute to safety measures by monitoring environmental conditions and equipment performance, aiding compliance with safety standards.
- Tools like Total Quality Management (TQM) combined with IIoT data ensure adherence to safety protocols for sustainable and safe operations.

Challenges & Benefits in implementing IIOT:

Challenges:

Interoperability and Compatibility: Integrating diverse systems and devices can be challenging due to differing protocols and standards, leading to compatibility issues.

Security Concerns: Increased connectivity opens avenues for cyber threats. Ensuring robust security measures to protect data and systems becomes crucial.

Data Management and Analytics: Handling vast amounts of data generated by IIoT devices requires robust infrastructure and advanced analytics capabilities to derive meaningful insights.

Cost of Implementation: Upgrading existing systems, investing in IoT-enabled devices, and implementing necessary infrastructure can be costly.

Skill Gap: There might be a shortage of skilled professionals capable of managing and maintaining IIoT systems and leveraging data analytics effectively.

Scalability and Complexity: As the scale of IIoT systems grows, managing the complexity and scaling up operations without disruptions can pose significant challenges.

Benefits:

Operational Efficiency: IIoT enables real-time monitoring and analysis, optimizing operations, reducing downtime, and enhancing productivity.

Predictive Maintenance: Early detection of equipment issues through IIoT sensors allows for predictive maintenance, reducing downtime and repair costs.

Data-Driven Insights: Access to granular data provides valuable insights for informed decision-making, process optimization, and better resource utilization.

Improved Quality Control: Continuous monitoring and data analysis ensure higher product quality and consistency, reducing defects.

Enhanced Safety: IIoT sensors can monitor workplace conditions, ensuring compliance with safety regulations and minimizing risks.

Supply Chain Optimization: Improved visibility and traceability across the supply chain result in streamlined logistics, reduced errors, and better inventory management.

Sustainability: Optimizing energy usage, reducing waste, and improving overall efficiency contributes to sustainability efforts.

UNIT -01: COMPLETED