Internet of Things

Reference Books

Mayur Ramgir, “Internet of Things - Architecture, Implementation, and Security”, 1st Edition, Pearson Publication, 2019 for Units I,II,III.

Derek Molloy, “Exploring Raspberry Pi Interfacing to the Real World with Embedded Linux”, 1st Edition, John Wiley & Sons Inc., 2016 for Unit IV.

Perry Lea, “Internet of Things for Architects: Architecting IoT solutions by implementing Sensor Communication Infrastructure, Edge Computing, Analytics and Security”, 1st Edition, Packt Publisher, 2018 for Unit V.

What is IoT ?

The network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.

IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

Internet of Everyting

What is IoT ?

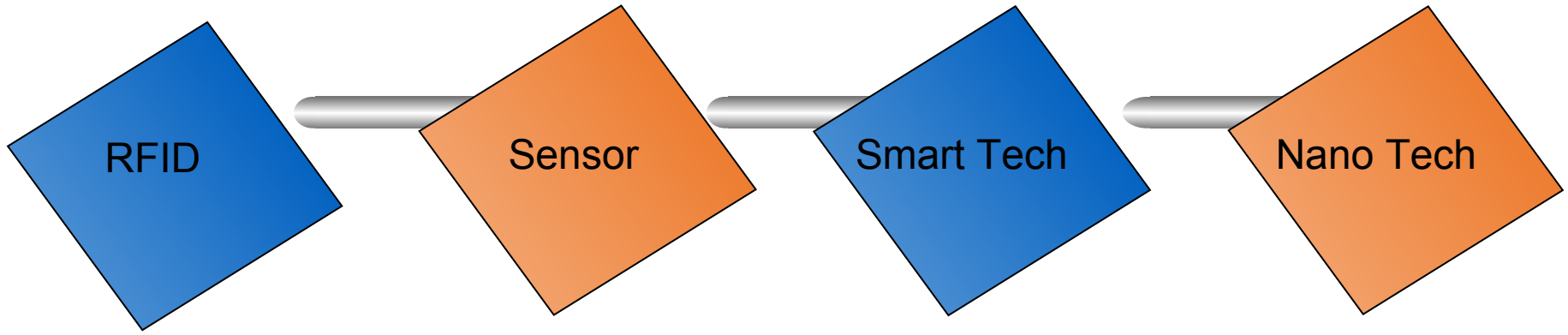
IoT is a sensor network of billions of *smart devices* that connect people, systems and other applications to collect and share data.

IoT wants to connect all potential objects to interact each other on the internet to provide secure, comfort life for human .

The internet of things helps people live and work smarter, as well as gain complete control over their lives.

Common instances for embedded computing devices are MP3 players, MRI, traffic lights, microwave ovens, washing machines and dishwashers, GPS even heart monitoring implants or biochip

How IoT Works?



To identify and track the data of things	To collect and process the data to detect the changes in the physical status of things	To enhance the power of the network by devolving processing capabilities to different part of the network.	To make the smaller and smaller things have the ability to connect and interact.

The Structure of IoT

The IoT can be viewed as a gigantic network consisting of networks of devices and computers connected through a series of intermediate technologies where numerous technologies like RFIDs, wireless connections may act as enablers of this connectivity.

- ***Tagging Things***

  Real-time item traceability and addressability by ***RFID***s.

- ***Feeling Things***

  Sensors act as primary devices to collect data from the environment.

- ***Shrinking Things***

  *M*iniaturization and ***Nanotechnology*** has provoked the ability of smaller things to interact and connect within the “things” or “smart devices.”

- ***Thinking Things***

  Embedded intelligence in devices through sensors has formed the network connection to the Internet. It can make the “things” realizing the intelligent control.

Why IoT ?

Environmental Monitoring

with the aid of water or soil or air measurment device can say us how are well for which plant

with the aid of earthquake or tsunami warning systems we can prevent less damages and victims

we can monitor wild life habit and by this tracking prepare them their desire condition and prevent their extinction

Infrastructure Management

monitoring and tracking if there is any problem in urban or rural Infrastructure such as bridge , railway or etc to diminish and reduce risk of dangeour and any failure in strength would be tested and alarm as soon as possible to repair it.

Industrial Applications

Industrial Applications investigate the quality of product in order to realtime optimizing to have a good marketing

most intersed to which product and how this product can find marketing with which tiny changes

Why IoT ?

Energy Management

Energy Management are categorized with systems which are connected to internet and with some sensor to reduce power consumption such as cloud based, remote control for oven , lamp and etc

Medical and Healthcare Systems

Healthcare Systems helps to improve patient state better by monitoring and controling their heart rate or blood pressure or even for their diet.

smart tablet which show us how much dows with which gradient can helps patient to get better.

Why IoT ?

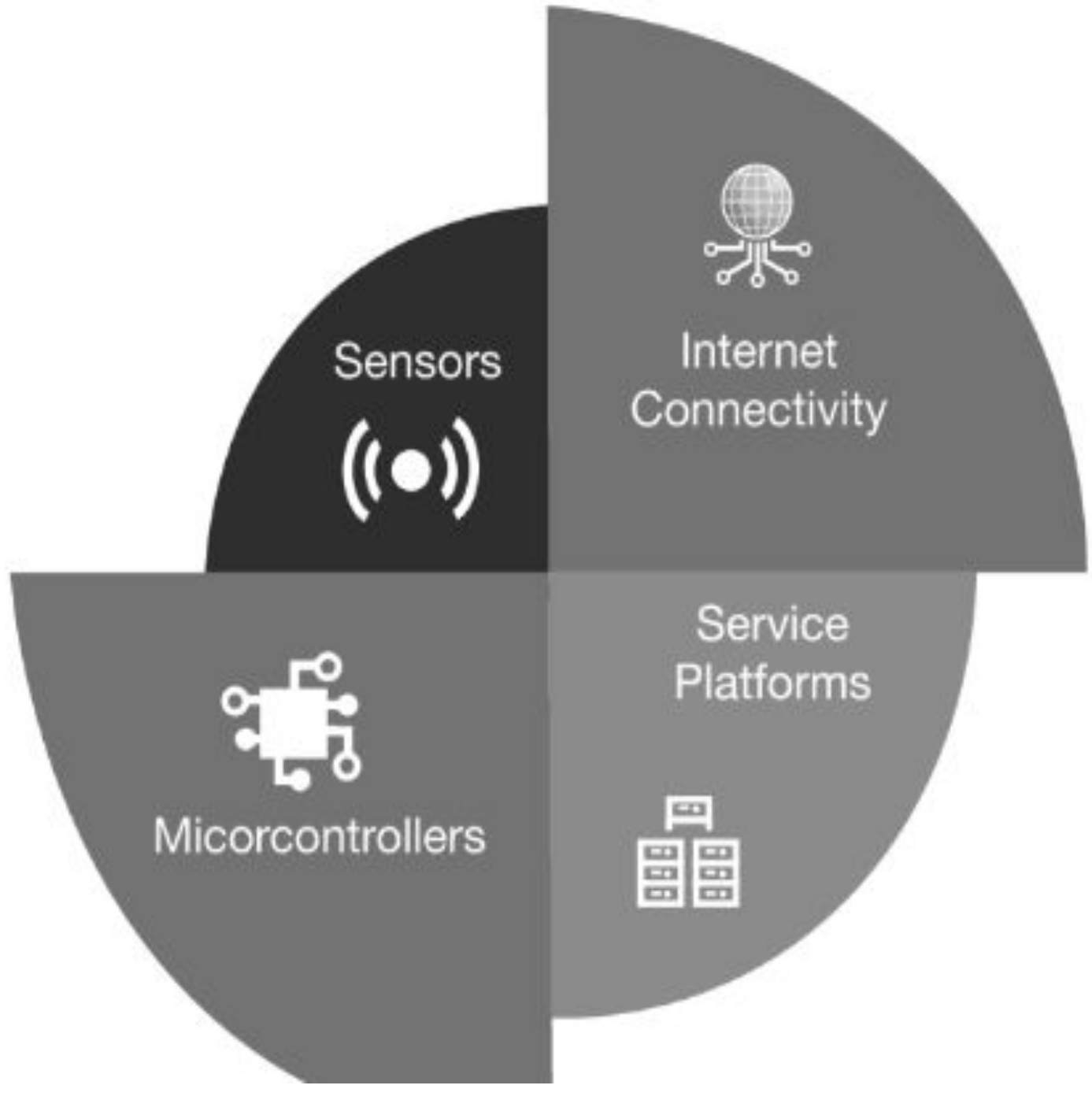
Building and Home Automation

It is related to everything in home which have the potential to monitor and remote control such as air condition , security lock lightening, heating, ventilation, telephon syatem, tv to make a comfort , secure , with low energy consumption.

Transport Systems

Transport Systems makes regular city and environment without less employeer for police or station such as automatic configuration in traffic lights, smart arking , traffic camera to detect which road has heavy traffic and offer automatically less crowd road, or smart camera which fine driver in high speed.

Three Technologies Tiers used in IoT



Three Technologies Tiers used in IoT

Tier 1

Sensors are installed into the physical environment or objects to gather data and events.

Tier 2

Microcontroller and Internet connectivity are responsible for sharing gathered information by using sensors installed in the IoT implementation.

It also acts on the basis of this gathered information to alter the environment.

Tier 3

By using the aggregation and analysis of data, service platforms are able to provide the necessary support to help in the smooth functioning of all the sensors

First Two tiers deals hardware

Use of Sensors

A sensor is a device, module, machine, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor.

A sensor is always used with other electronics.

the sensors have become so tiny that they can be attached to almost all the devices we use personally and professionally

Bluetooth technology will aid to share the data among sensors

Ex:

The Bluetooth connectivity creates a communication medium between the watch/band and smartphones.

On one hand, the band/watch can send collected data from sensors to the smart- phone.

On the other hand, the smartphone can send notification alerts to the watch/band.

sensor is embedded in the contact lens and clothing.

Magnetic tattoos that vibrate from incoming calls and messages

Use of Sensors

Magnetic tattoos that vibrate from incoming calls and messages.

This space-age sounding technology was possible by stamping a material into your skin.

After this, the material gets paired with your smartphone to receive vibrating alerts.

Researchers at Microsoft and the University of Washington worked together to develop **IoT contact lenses** that could be implanted into your body to get real-time updates about the biochemical changes inside your body.

The diabetes patients could use these contact lenses to monitor their insulin levels.

The Use of Microcontrollers and Internet Connectivity

Very Small computer with CPU

helps device storage and process of preprocessing before sending it to cloud

local storage of data,

data processing and

internet connectivity.

If we want to send the gathered data to the cloud database, the IoT needs internet connectivity.

advanced sensors could generate over 10,000 data points per second.

Thus, it makes it very important to process and analyze the data locally before sending it to the cloud database

The microcontroller comprises of a processor, a tiny amount of RAM to hold data, flash memory or EPROM to have embedded software, and solid-state memory to enable caching of data

Networking - **wired or wireless**

wired connection uses external power source - rely on batteries

Wireless - WiFi,Wirelees modems and wireless mesh networks to connect to the internet

Services Platform

for storing and making decisions based on the collected data from every type of

IoT devices

Deals with software

Cloud Appl is responsible for combining data collected from various IoT sensors

to provide useful insights that creates a business value

users can upgrade,monitor and maintain the firmware on any device.

IoT Revolution

a new paradigm that has changed the traditional way of living into a high tech life style.

Smart city, smart homes, pollution control, energy saving, smart transportation, smart industries are such transformations due to IoT.

IoT is progressively becoming an important aspect of our life that can be sensed everywhere around us.

In whole, IoT is an innovation that puts together extensive variety of smart systems, frameworks and intelligent devices and sensors

The Connected Age or the Age of Sensorization

Connected Age is data – data that can be collected, data that can be analysed, data can be shared and data can be used to improve many service offerings.

The Robotic Age or the Age of Artificial Intelligence

Benefits of IoT : End Users

Easy of Doing Things

Smart home

the ability to control domestic appliances by electronically controlled, internet-connected systems

Emergency Services

Elderly people monitoring, accident detection devices

health conditions such as heart attack,accidents like fall

Security services

Motion sensors are critical for ensuring the safety of your home. These IoT sensors can alert you of any suspicious activity inside or around your home. They sense motion or vibration and can respond to 2D or 3D gestures.

Smart Cameras,Biometric Locks,Video Door Entry Systems,Fire/Smoke Sensors,Motion Sensors

Benefits of IoT : Businesses

Process improvements

Automation at every stage to increase overall productivity

Ex: Sensor tracking the manufacturing process from raw material acquisition to selling the finished goods in the shops

Sensors to schedule the manufacturing operations

Asset Utilization

Tracking the assets like machines, equipment, tools and soon

Maintenance can be schedule and fault can be detected in the real tiume

New market Opportunities

Reduces time to market and brings consumers closer to the brands

Ex: Retailers can use IoT to measure in-store foot traffic to optimize displays for maximum impact based on customer habits.

Workplace security

Monitoring specific zones with motion detection cameras and processing the images with computer vision algorithms to detect security flaws

Cost reduction

On-the-fly troubleshooting of office equipment catches problems before they impact staff and employees, saving the hassle and costs of large repairs.

IoT Implementation Challenges

Security

Regulatory and Legal Issues

Network Latency

Unavailability of standardized platform and common Architecture

Scalability

Limited Types of sensors

Power Supply

IoT Implementation Challenges : Security

Lack of visibility
Users often deploy IoT devices without the knowledge of IT departments, which makes it impossible to have an accurate inventory of what needs to be protected and monitored.

Limited security integration
Because of the variety and scale of IoT devices, integrating them into security systems ranges from challenging to impossible.

Open-source code vulnerabilities
Firmware developed for IoT devices often includes open-source software, which is prone to bugs and vulnerabilities.

Overwhelming data volume
The amount of data generated by IoT devices make data oversight, management, and protection difficult.

Poor testing
Because most IoT developers do not prioritize security, they fail to perform effective vulnerability testing to identify weaknesses in IoT systems.

Vulnerable APIs
APIs are often used as entry points to command-and-control centers from which attacks are launched, such as SQL injection, distributed denial of service (DDoS), man-in-the-middle (MITM), and breaching networks

Weak passwords
IoT devices are commonly shipped with default passwords that many users fail to change, giving cyber criminals easy access. In other cases, users create weak passwords that can be guessed.

IoT Implementation Challenges : Regulatory and Legal Issues

The Internet of Things (IOT) raises legal and regulatory challenges, mainly in the area of privacy and security.

- Who owns the data
- anytime you connect something to the Internet, you open it up to an attack
- Are there privacy policies for IOT? What privacy protections exist? What can the devices learn about you that you want to keep private?

Big market players in IOT will include:

- Self-driving cars (reduce accidents)
- Smart meters on household devices
- Surveillance
- Stores
- Home health care and hospital care

IoT Implementation Challenges

Network Latency

Latency is affected by several factors: distance, propagation delay, internet connection type, website content, Wi-Fi, and your router.

The longer the device is asleep, the less power it consumes. This also means that there are fewer opportunities for information to be exchanged. This impacts the performance of the device, causing it to run slower (known as latency)

The amount of time between when data is sent from a connected device to when it returns to the same device – which in turn limits IoT solutions' effectiveness

Unavailability of standardized platform and common Architecture

One of the many significant issues is the multitude of languages, protocols and standards, as well as the lack of agreement on which it works best for individual layers of the IoT.

It does not have a single platform of standardization; it is changed due to the heterogeneity of connected things.

IoT Implementation Challenges

Scalability

The capability of a system to manage an increasing quantity of work by adding extra resources

if not handled early enough, such vulnerabilities might evolve into problems that risk higher

maintenance hours and latency issues.

Sensors

related to the reduction of their cost, size, and energy consumption.

Moreover, additional efforts in design and development of nanoscale sensing materials have to

be made to achieve improved device performance.

Power supply

IoT devices are often powered by a battery because they do not have direct access to a power

supply.

This is often caused by being located in places where access to the electric network is simply

not possible.

Real World Applications of IoT : Industrial & Manufacturing

Industrial IoT (IIoT) brings machines, cloud computing, analytics, and people together to improve the performance and productivity of industrial processes.

With IIoT, industrial companies can digitize processes, transform business models, and improve performance and productivity, while decreasing waste.

- Automated and remote equipment management and monitoring.
- Predictive maintenance.
- Faster implementation of improvements.
- Pinpoint inventories.
- Quality control.
- Supply chain optimization.
- Plant safety improvement.

Real World Applications of IoT : Consumer

The Consumer IoT refers to the billions of physical personal devices, such as smartphones, wearables, fashion items and the growing number of smart home appliances, that are now. connected to the internet, collecting and sharing data.

1. Personal IoT:

Devices that are used for personal use such as watches and phones come under the personal category of consumer IoT.

They include devices such as smart shirts, smart watches, wearables, smartphones and so on.

2. Smart home IoT:

Smart Home involves home appliances operating under an IoT ecosystem. These devices have access to the internet, sense the environment around them and retrieve data from devices simultaneously.

Smart homes include devices such as smart TVs, smart ovens, smart geysers, smart refrigerators, thermostats, voice assistance, security systems, lightning controllers and family entertainment devices.

Real World Applications of IoT : Retail

to help retailers personalize the shopping experience.

*tightly connected to GPS and RFID technologies (*Radio Frequency Identification)

help brands track products through the entire supply chain process.

It gives retailers the visibility they need to monitor product movement, conditions and track location as well as predict a precise delivery time.

Ex: *For instance, managers can test different vendors, vehicles, and delivery routes, collect the data on the process and find the cheapest and safest framework for managing products.*

- Automated packaging services;
- IoT drones for inventory monitoring;
- IoT in facility management.

IoT applications in retail

Location tracking

Predictive equipment maintenance

Inventory management

Personalized alerts

Smart shelves :an RFID tag, an RFID reader, and an antenna.

Real World Applications of IoT : Marketing

helping companies better market their products and services as they are able to collect more data from customers.

This data is valuable as it provides insights into consumer behavior, making it easier to market products/services with success.

to listen to customer needs and respond appropriately.

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Understanding of the consumer's mindset and their purchasing habits

Marketing strategies – FitBit

A brand that enables IoT enabled wearable

Customer can share their experience with their friends on social media platforms

Like product reviews free marketing

Real World Applications of IoT : Finance

helping financial institutions keep up with customer expectations and stay ahead of their competitors.

The technology enables them to offer personalized services to meet their customers' needs better.

IoT is changing how end-users interact with banks - from managing their finances to making transactions better detect any fraudulent activity.

IoT for Smart Banking and Finance · Customer view · Automation · Enhanced security · Fraud detection · One-touch payments.

Ex:

In banks, a client can monitor the lines at the branch online or schedule cash withdrawal and complete the act at any nearest ATM. All thanks to the smart IoT devices!

Device-to-device communication has a wide range of applications.

Firstly, leveraging IoT in banks enables automated cashless payments.

Secondly, insurance companies can use IoT tools to offer financial advice to the customers based on their spending habits.

Real World Applications of IoT : Healthcare

explores new dimensions of patient care through real-time health monitoring and access to patients' health data.

to improve patient's health and experiences while making revenue opportunities and improving healthcare operations.

IoT for Patients

Devices in the form of wearables like fitness bands and other wirelessly connected devices like blood pressure and heart rate monitoring cuffs, glucometer etc. give patients access to personalized attention. These devices can be tuned to remind calorie count, exercise check, appointments, blood pressure variations and much more.

IoT for Physicians

IoT enables healthcare professionals to be more watchful and connect with the patients proactively. Data collected from IoT devices can help physicians identify the best treatment process for patients and reach the expected outcomes. – Proactive treatment

IoT for Hospitals

IoT devices tagged with sensors are used for tracking real time location of medical equipment like wheelchairs, defibrillators, nebulizers, oxygen pumps and other monitoring equipment.

Real World Applications of IoT : Transportation and Logistics

It acts as a medium that facilitates the movement of people, goods, and products from one location to another.

Through built-in sensors and onboard diagnostics systems, conventional trucks are transformed into data-transmitting vehicles, allowing managers to track their vehicles, respond to changing environments and identify inefficient activity in real-time.

transport and logistics industry is often called telematics, which is the foundational technology behind fleet tracking and fleet management software.

fleet management

Data capture devices installed on vehicles or mobile assets can transmit critical information to a web-based software platform via secure cellular networks.

help fleet managers gain real-time visibility into their operations while increasing driver satisfaction and decreasing fuel usage through predictive analytics and accurate reporting.

to monitor fleet activities and make decisions about proper asset management, dispatch and routing, and vehicle acquisition and disposal.

Real World Applications of IoT : Agriculture and Environment

Agriculture :

Focused on helping farmers close the supply demand gap, by ensuring high yields, profitability, and protection of the environment.

The approach of using IoT technology to ensure optimum application of resources to achieve high crop yields and reduce operational costs is called precision agriculture

Applications of IoT in Agriculture

- Precision Farming.
- Agricultural Drones.
- Livestock Monitoring.
- Smart Greenhouses, Computer imaging.
- Monitor Climate Conditions ,Remote sensing.

Environmental :

Environmental monitoring is the most beneficial IoT application.

It uses advanced sensor devices to identify the presence of pollutants in the air and water and promotes better sustainability.

You can keep the premises safer and cleaner by utilizing a smart environmental monitoring solution.

Real World Applications of IoT : Agriculture and Environment

Real World Applications of IoT : Energy

wide variety of energy control and monitoring functions, with applications in devices, commercial and residential energy use, and the energy source.

Residential Energy

simple switching off or dimming of lights, or changing device settings and modifying multiple home settings to optimize energy use.

Commercial Energy

process of energy monitoring and management while maintaining a low cost and high level of precision. It addresses all points of an organization's consumption across devices.

Reliability

detects threats to system performance and stability, which protects against losses such as downtime, damaged equipment, and injuries.

smart grids refer to a network of electric circuits that support a two-way energy flow and have a self-healing capacity for maintenance issues.

Smart Meter Technology

measurement and analysis of energy consumption by a particular household, building, or organization, the smart meter installation technology can help one analyze the areas

Real World Applications of IoT : Smart City

Smart cities use IoT devices such as connected sensors, lights, and meters to collect and analyze data.

The cities then use this data to improve infrastructure, public utilities and services, and more

Smart utility meters

These devices attach to buildings and connect to a smart energy grid, allowing the utility companies to manage energy flow more effectively.

Smart transportation

Smart grids

offering home energy storage units and solar panels for households that are connected to the city's smart grid.

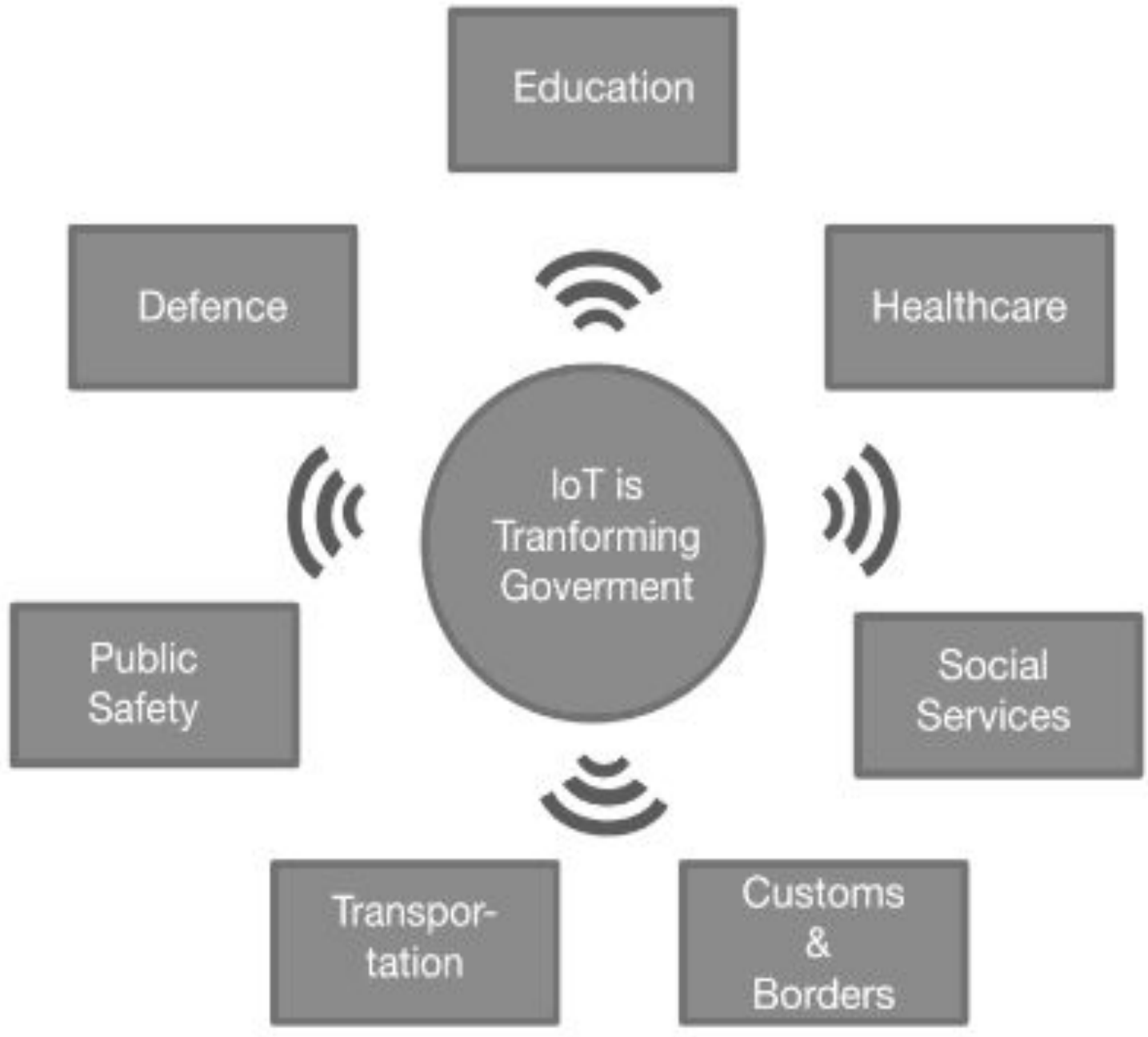
The solar panels also let residents sell spare energy

Smart air quality monitors

constantly air particles, dust, dirt, cleaning chemicals, floating around in the air of one's office building or home. Smart air quality monitors can detect these particles and inform users of pollutants.

Real World Applications of IoT : Smart City

Real World Applications of IoT : Goverment



Real World Applications of IoT : Military

military intelligence and command and control systems use the myriad of sensors that can be deployed in all the domains, allowing them to acquire full situational awareness and control over diverse conflict zones or battle areas.

for modern battle operations and intelligent warfare.

It refers to physical objects in the military domain, which are embedded with sensors, software, and other technologies.

These objects communicate with each other to collect and transfer data over the internet to accomplish a broad range of activities in a more efficient and informed way.

In IoMT and IoBT, the sensors are incorporated into the combat suits, helmets, weapons systems, and other equipment used by soldiers.

These sensors collect a variety of biometrics such as their iris, face, fingerprints, heart rate, gestures, and facial expressions.

Internet of Military Things (IoMT) or Internet of Battlefield Things (IoBT)

Applications of IoT

IoT applications are used to address many real-world issues –

traffic congestion,

city services,

economic development,

citizen engagement, and

public safety and security.

Smart cities often embed IoT sensors into the physical infrastructure, such as

streetlights, water meters and traffic signals.

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IoT Frameworks

Machine to machine interactions

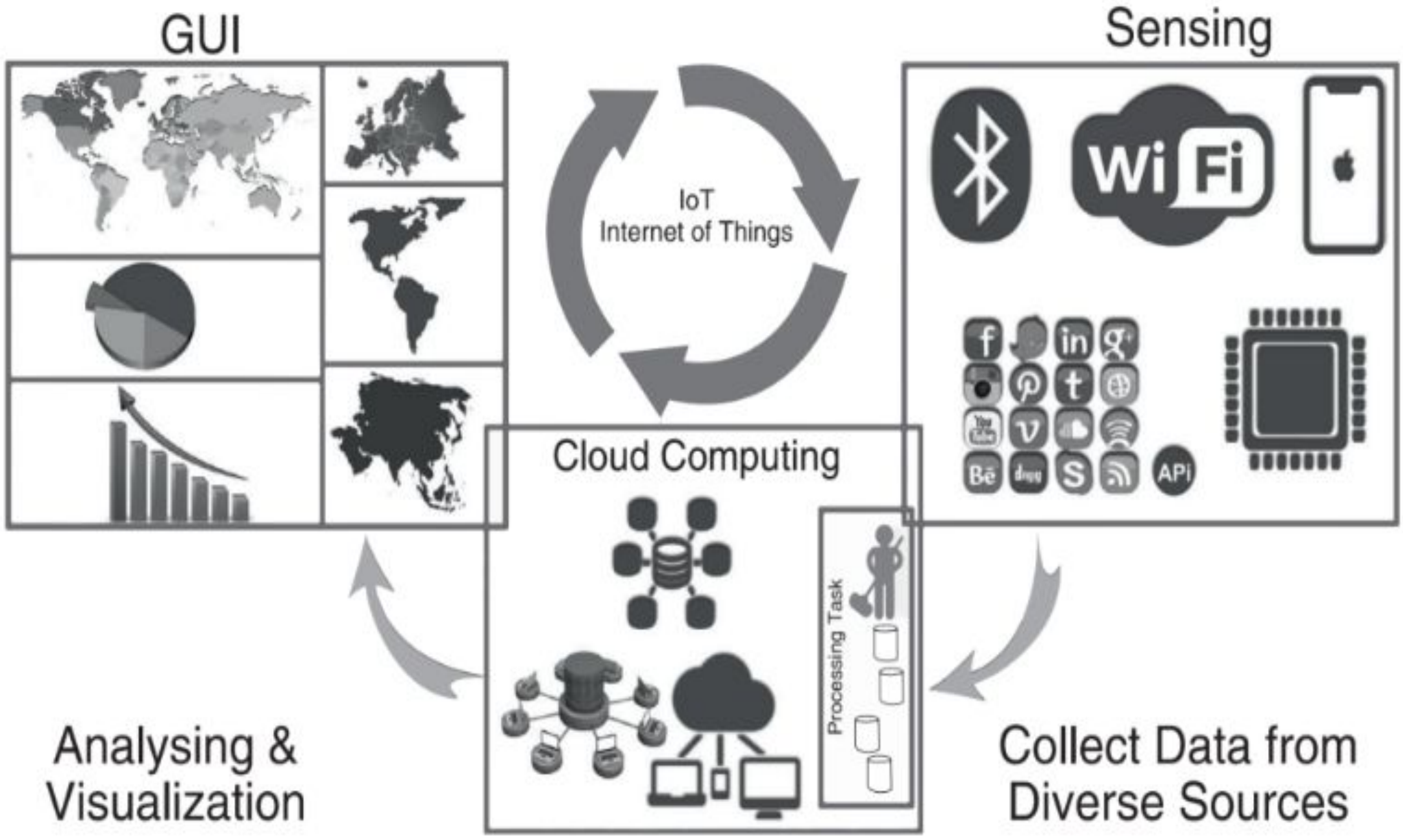
To enable machine to machine interaction need infrastructure which provide secure connectivity and data transfer reliability

Infrastructure is known as IoT framework or Platform

Consists of interconnected and interdependent components aids for building IoT Applications

- Sensors
- Sensors system
- Gateway for connection points
- App
- Embedded controller
- Data management platform
- Analytical platform

IoT Value Chain



IoT Frameworks and Platform : Real Time Innovations

The largest software framework company for autonomous systems.

leading architecture for developing intelligent distributed systems.

Uniquely, Connext shares data directly, connecting AI algorithms to real-time networks of devices to build autonomous systems.

The Industrial Internet of Things (IIoT) connectivity company and the largest vendor of products based on the Object Management Group (OMG) Data Distribution Service (DDS) standard.

OMG is a place where you can collaborate to create global standards to respond to the latest trends and technology needs.

DDS is the only open standard for messaging that supports the unique needs of both enterprise and real-time systems.

Software connectivity standard that enables secure realtime information exchange, modular application development and rapid integration in industrial IoT system

IoT Frameworks and Platform : Real Time Innovations

RTI Connext DDS

delivers the edge-to-cloud connectivity software needed to streamline, control and monitor the most demanding and mission-critical systems.

The RTI Connext databus is a software framework that shares information in real time, making applications work together as one, integrated system.

It connects across field, fog and cloud.

Its reliability, security, performance and scalability are proven in the most demanding industrial systems.

Cubic

Cubic Telecom is a global connectivity platform company that **offers mobility solutions that power connectivity for leading Internet of things (IoT), machine-to-machine (M2M) and mobile device companies across the globe**

Cubica works with multiple IoT communication protocols to ensure you have the proper connectivity for the right solution.

IoT Frameworks and Platform : Cisco

Cisco

the worldwide leader in IT and networking. We help companies of all sizes transform how people connect, communicate, and collaborate.

Cisco- IoT

helps enterprises connect and monitor devices, secure and automate operations, and compute and manage data.

Provides methods for management and storage of data centers and cloud platform

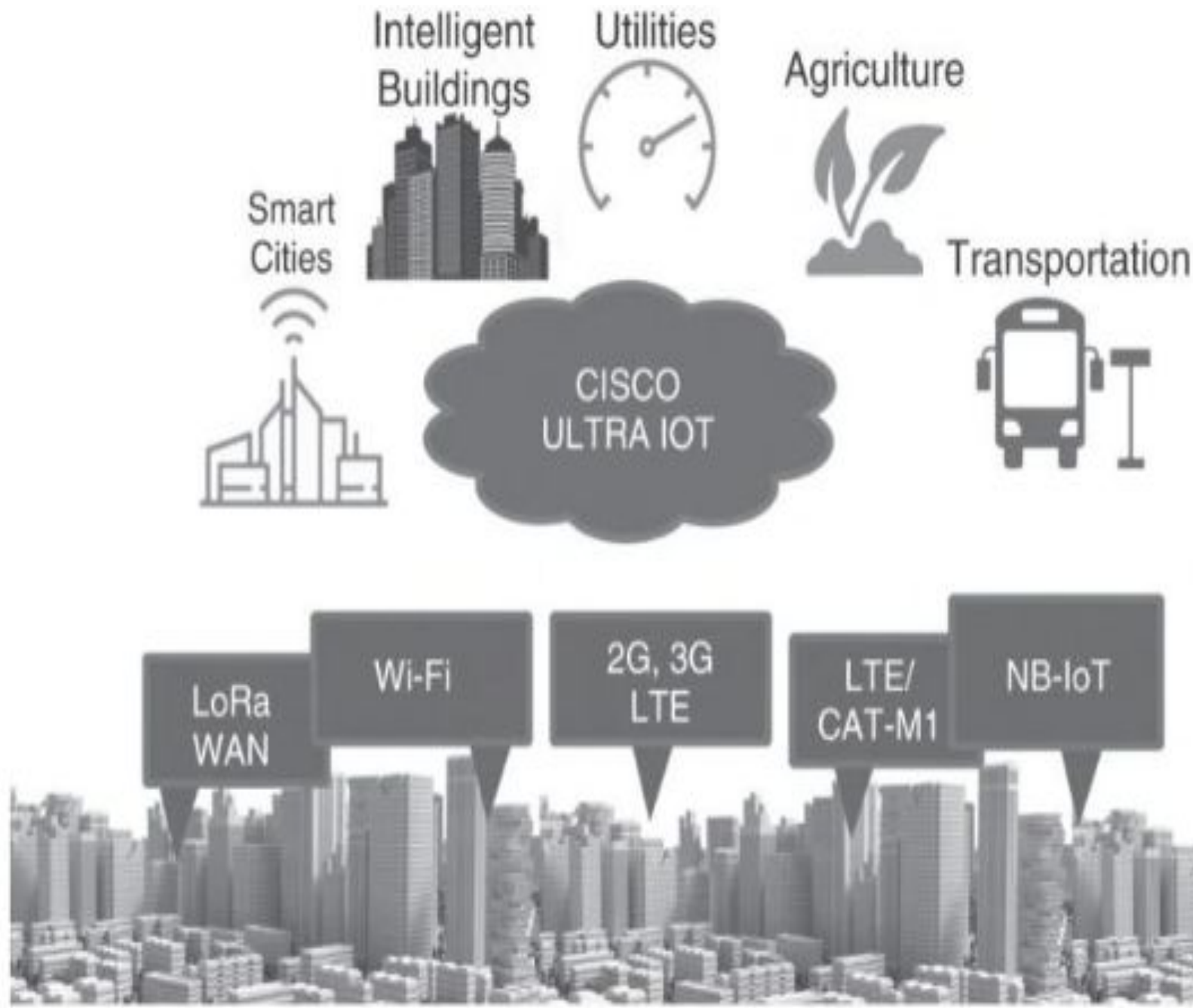
3 Components

- Virtualized data center
- Intelligent network
- Connected devices

Services

Network Connectivity - built routing, switching, and wireless products, Fog Computing - distributed computing, Security - cyber and physical security , Data Analytics, Management & Automation and Application Enablement Platform - Offers a set of APIs

IoT Frameworks and Platform : Cisco



IoT Frameworks and Platform : CISCO

LoRaWAN

Low-power, wide area networking protocol built on top of the LoRa radio modulation technique.

It wirelessly connects devices to the internet and manages communication between end-node devices and network gateways.

Cat-M1

LTE Cat-M, is a low-cost LPWAN technology developed by 3GPP as part of the 13th edition of LTE standard.

LPWAN (Low Power Wide Area Network), is a wireless data transport protocol that is now understood as one of the basic protocols for the implementation of IoT.

NarrowBand-Internet of Things (NB-IoT)

Standards-based low power wide area (LPWA) technology developed to enable a wide range of new IoT devices and services.

NB-IoT significantly improves the power consumption of user devices, system capacity and spectrum efficiency, especially in deep coverage.

Company Challenges :

Difficulty in the provision of dependable and premium quality services

Struggling to monitor and engage in the automation of its systems from the outside of its plants

Streamline its operations Via a fully-connected infrastructure

Advanced Metering Infrastructure (AMI)

utilities to achieve business goals by saving truck rolls, enabling demand response, fast outage notification, and preventing power theft.

Cisco’s AMI Validated Design is based on Wi-Sun mesh which provides standard based scalable, resilient, OpEx effective, and secure smart meter networking.

Wireless Smart Ubiquitous Network (Wi-SUN)

Wi-SUN enables utilities, municipalities, and other enterprises to deploy long-range, low-power wireless mesh networks connecting thousands of IoT nodes.

IoT Frameworks and Platform : CiSCO

Cisco Network Services Orchestrator

NSO provides a robust bridge linking network automation and orchestration tools with the underlying physical and virtual infrastructure.

orchestration platform for hybrid networks. It provides comprehensive lifecycle service automation to enable you to design and deliver high-quality services faster and more easily.

Orchestration

the automated configuration, coordination, and management of computer systems and software

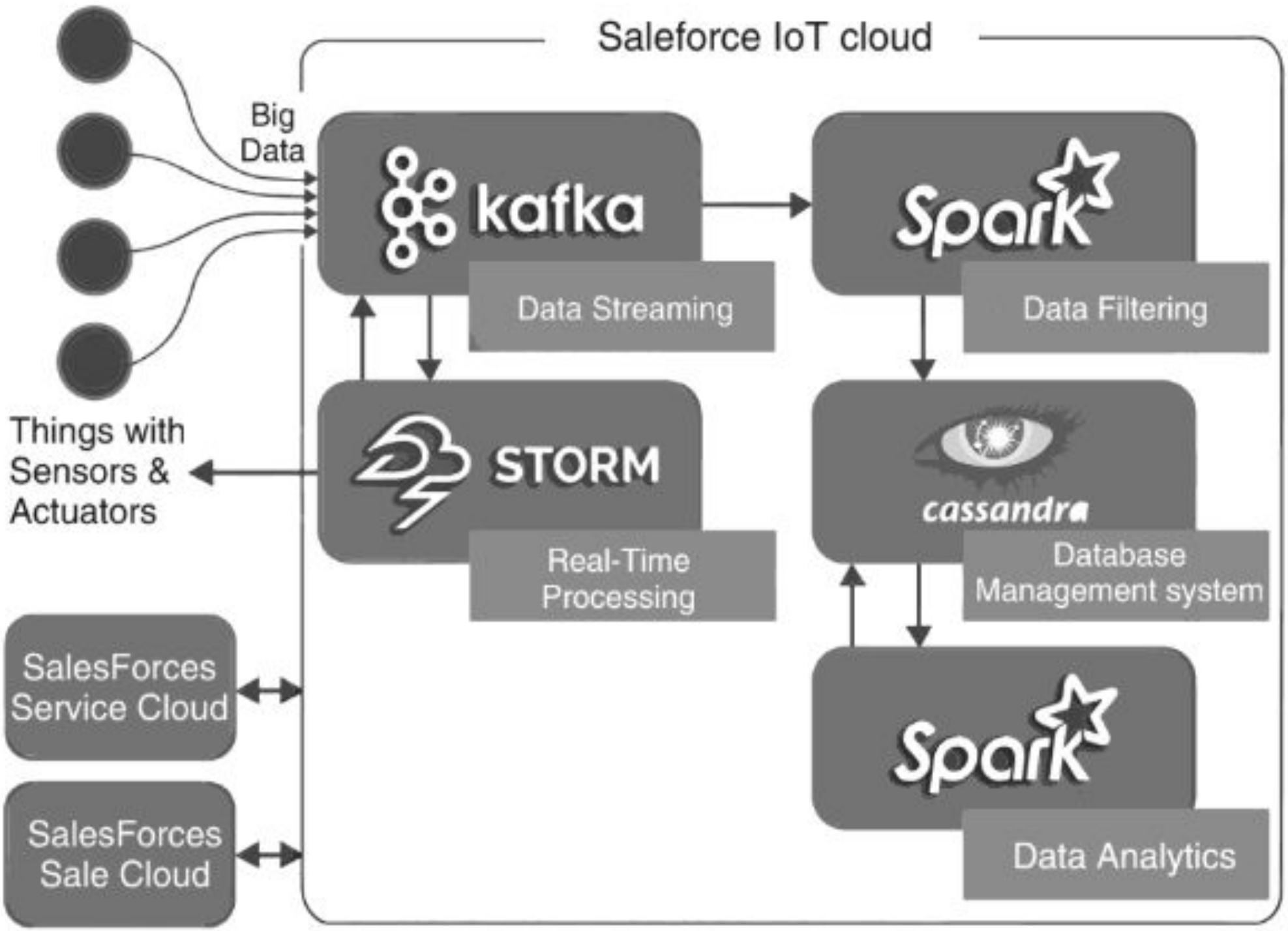
PDI

Planning and design and implementation

Build the network hierarchy and image repository, and configure network settings.

Streamline IT operations with custom network and IT service management (ITSM) solution integration.

IoT Frameworks and Platform : Salesforce



IoT Frameworks and Platform : Salesforce

The Salesforce IoT Cloud is a platform for storing and processing IoT data.

It uses the Thunder engine for scalable, real-time event processing.

Its collection of application development components, known as Lightning, powers its applications.

It gathers data from devices, websites, applications, customers, and partners to trigger actions for real-time responses.

Back of an event processing engine – Thunder

Thunder is designed on he back of the following Apache's technologies

Kafka

Kafka APIs are used to implement data pipelines, real-time data streams, etc.

Kafka APIs store data in topics

event streaming platform

It makes it simple to quickly define connectors that move large data sets

IoT Frameworks and Platform : Salesforce

Spark

a fast and general engine for large-scale data processing and batching via distributed computing

Storm

Used in Big Data solutions to work with real time data

Cassandra

Cassandra Query Language.

It is very important to create different role for different type of users to provide access with a specific requirements.

It is used to provide security for Database users or group of users

Working of Salesforce in IoT

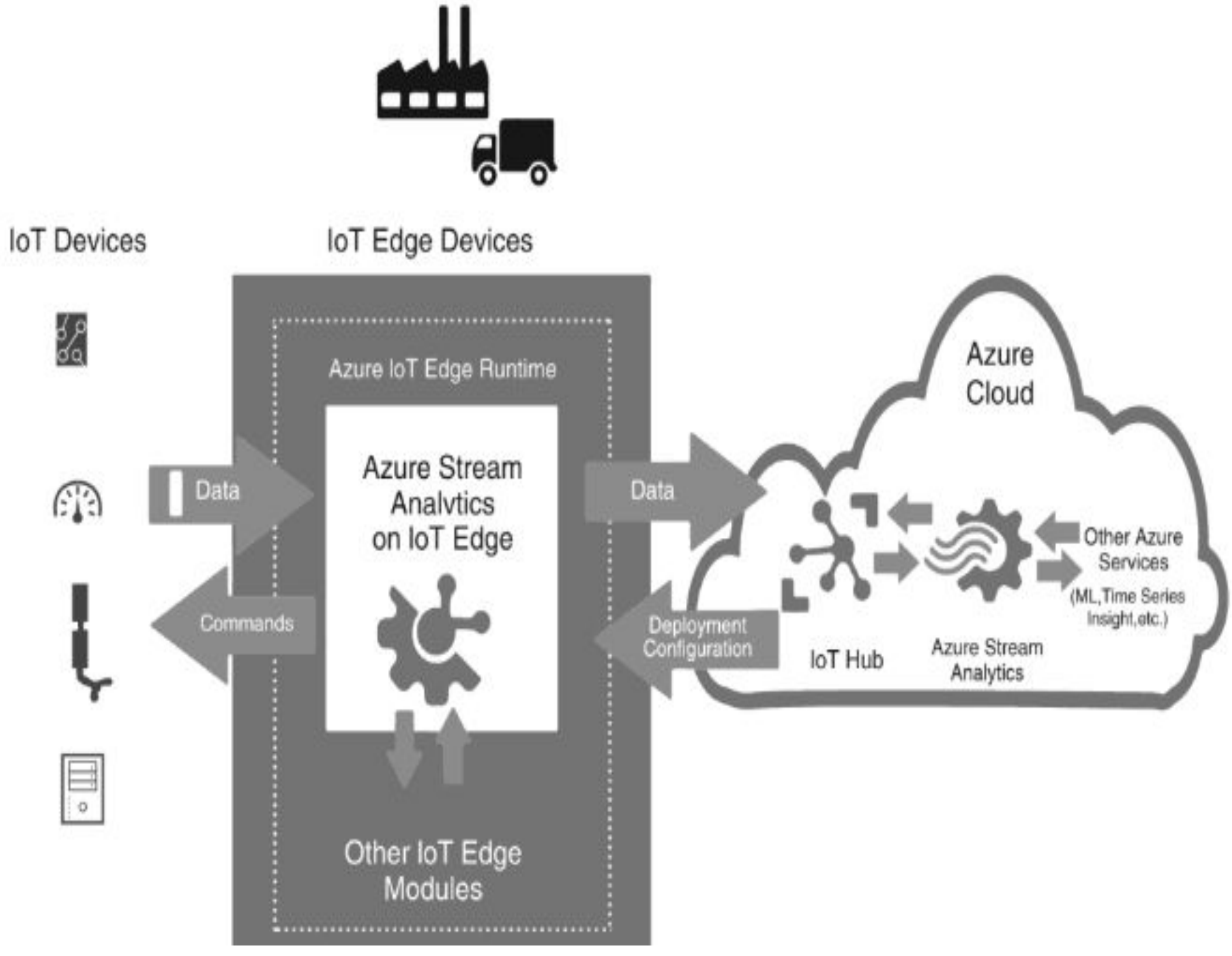
new data sent from the Salesforce IoT Systems sent to Kafka

Where spark is responsible to transmit it to cassendra

Meanwhile storm analyze the dataset to formulate responses for the current events

PAAS – salesforce's Heroku PaaS

Azure IoT


IoT Devices
IoT Edge Devices
Azure IoT Edge Runtime
Azure Stream Analytics on IoT Edge
Other IoT Edge Modules
Data
Commands
Data
Deployment Configuration
Azure Cloud
Other Azure Services
(ML, Time Series Insight, etc.)
IoT Hub
Azure Stream Analytics

Azure IoT

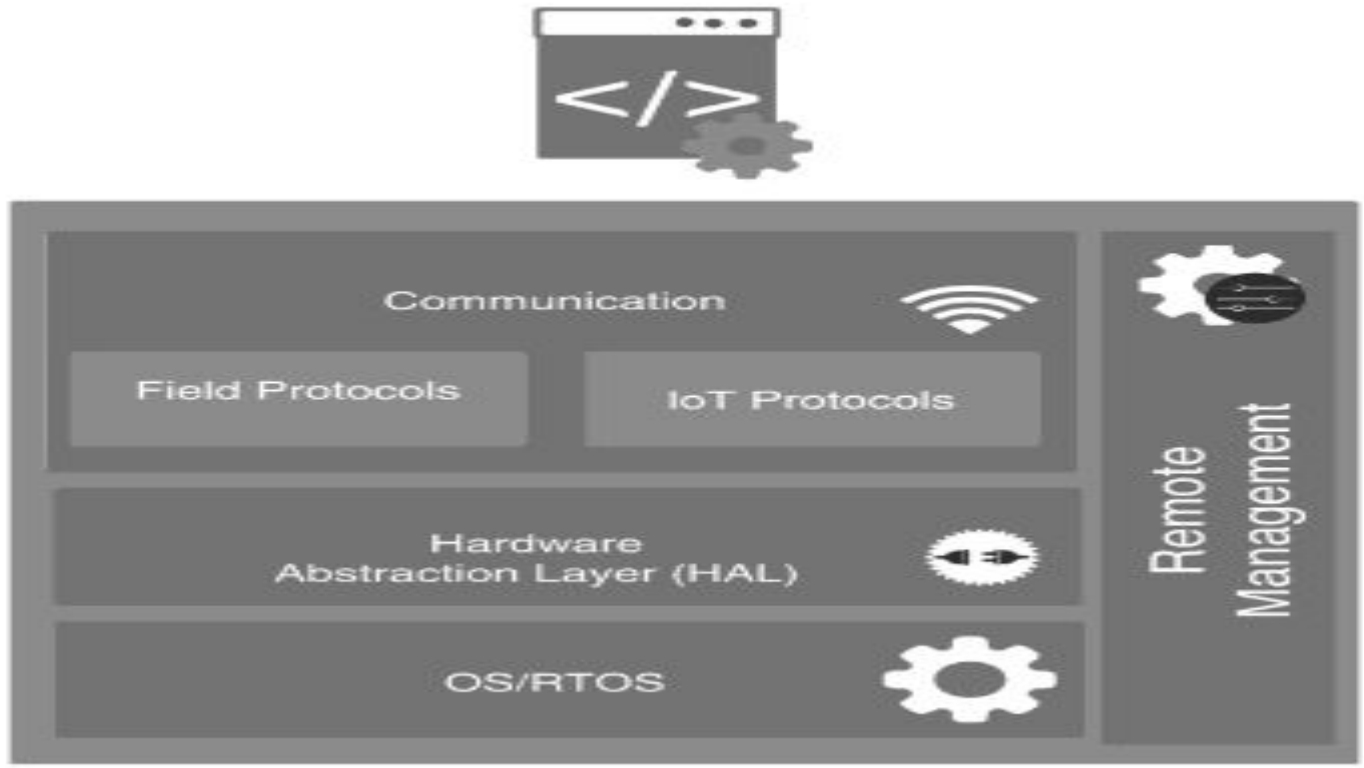
A managed service hosted in the cloud that acts as a central message hub for communication between an IoT application and its attached devices.

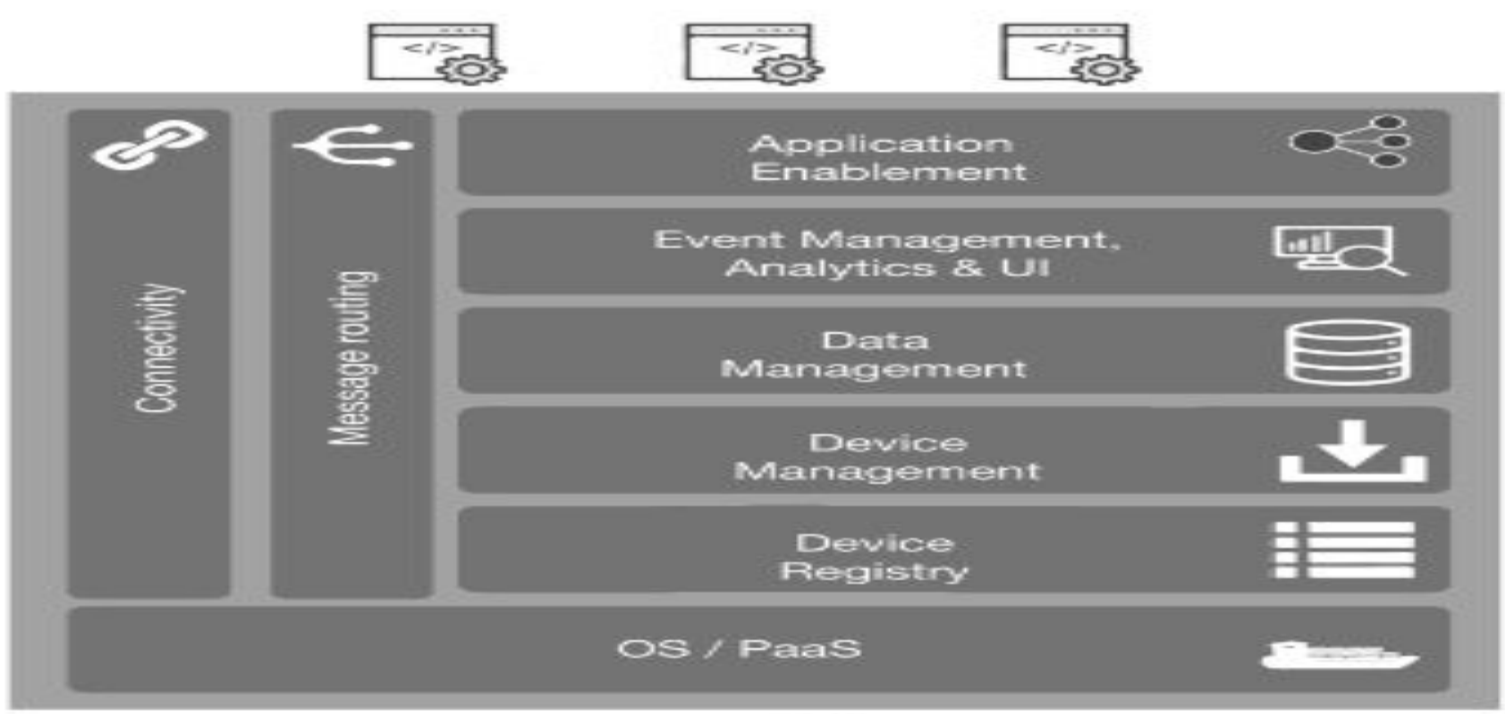
The users can connect millions of devices and their backend solutions reliably and securely.

It also includes security and operating systems for devices and equipment, along with data and analytics that help businesses to build, deploy and manage IoT applications.

- Connect, monitor and manage billions of IoT assets
- Authenticate every device for enhanced security
- Automate device provisioning to accelerate IoT deployment
- Extend the power of the cloud to your edge devices
- Security-enhanced communication channel for sending and receiving data from IoT devices

Eclipse IoT


Communication
Field Protocols
IoT Protocols
Hardware
Abstraction Layer (HAL)
OS/RTOS
Remote
Management


Connectivity
Message routing
Application
Enablement
Event Management,
Analytics & UI
Data
Management
Device
Management
Device
Registry
OS / PaaS
IoT Cloud Platform

Eclipse IoT

an ecosystem of entities (industry and academia) working together to create a foundation for IoT based exclusively on open source technologies.

producing open source implementations of IoT standard technology; creating open source frameworks and services for utilization in IoT solutions; and developing tools for IoT developers

Smarthome Project

It aims to create a framework for building smart home solutions, and its focus remains heterogeneous environments, meaning assorted protocols and standards integration.

provides uniform device and information access to facilitate interaction between devices. It consists of OSGi bundles capable of deployment in an OSGi runtime, with OSGi services defined as extension points.

OSGi bundles are Java class groups and other resources, which also include detailed manifest files. The manifest contains information on file contents, services needed to enhance class behavior, and the nature of the aggregate as a component.

Eclipse IoT:example of a manifest

Bundle-Name : Hi Everyone // Bundle Name

Bundle-SymbolicName : xyz.xyz.hievery1 // Header specifying an identifier

Bundle-Description : A Hi Everyone bundle // Functionality description

Bundle-ManifestVersion : 2 // OSGi specification

Bundle-Version : 1.0.0 // Version number of bundle

Bundle-Activator : xyz.xyz.Activator // Class invoked on bundle activation

Export-Package : xyz.xyz.helloworld;version = "1.0.0" // Java packages available externally

Import-Package : org.osgi.framework;version = "1.3.0" // Java packages needed from

// external source

Eclipse IoT: Eclipse SCADA

Delivers a means of connecting various industrial instruments to a shared communication system.

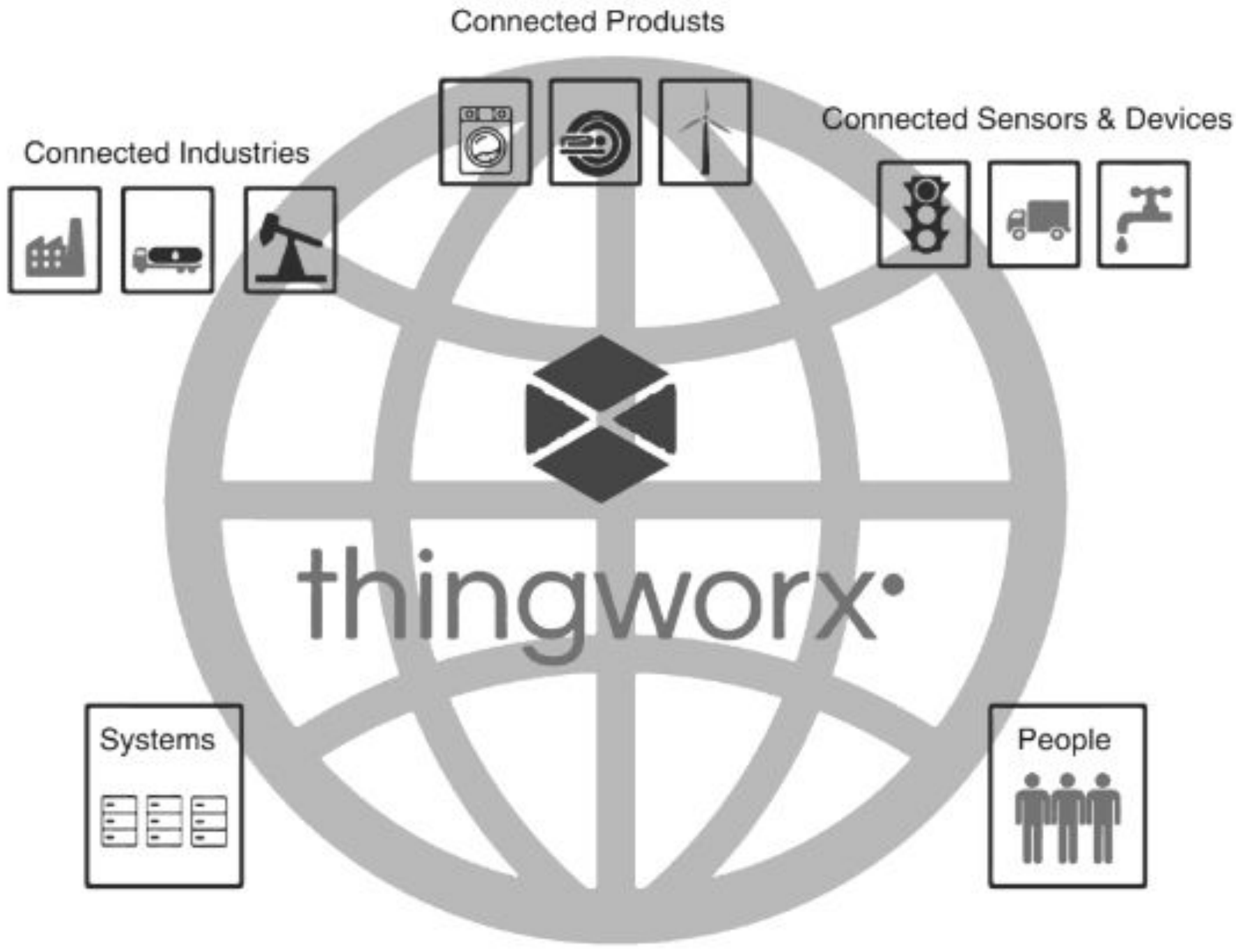
post-processes data and sends data visualizations to operators.

Uses a SCADA system with a communication service, monitoring system, archive, and data visualization.

open source SCADA system for developing custom solutions.

Its supported technologies and tools include shell applications, JDBC, Modbus TCP and RTU, Simatic S7 PLC, OPC, and SNMP.

ThingWrox


Connected Produsts
Connected Industries
Connected Sensors & Devices
thingworx
Systems
People

ThingWrox

a platform for the rapid development and deployment of smart, connected devices.

Its set of integrated IoT development tools support connectivity, analysis, production, and other aspects of IoT development.

implementing augmented reality development, and Kepware for industrial connectivity.

KEPServerEX provides a single point for data distribution, and facilitates interoperability when partnered with a ThingWorx agent.

Users connect devices, establish a data source, establish device behaviors, and build an interface without any coding.

It also offers scalability appropriate for both hobbyist projects and industrial applications.

ThingWrox : Advantages

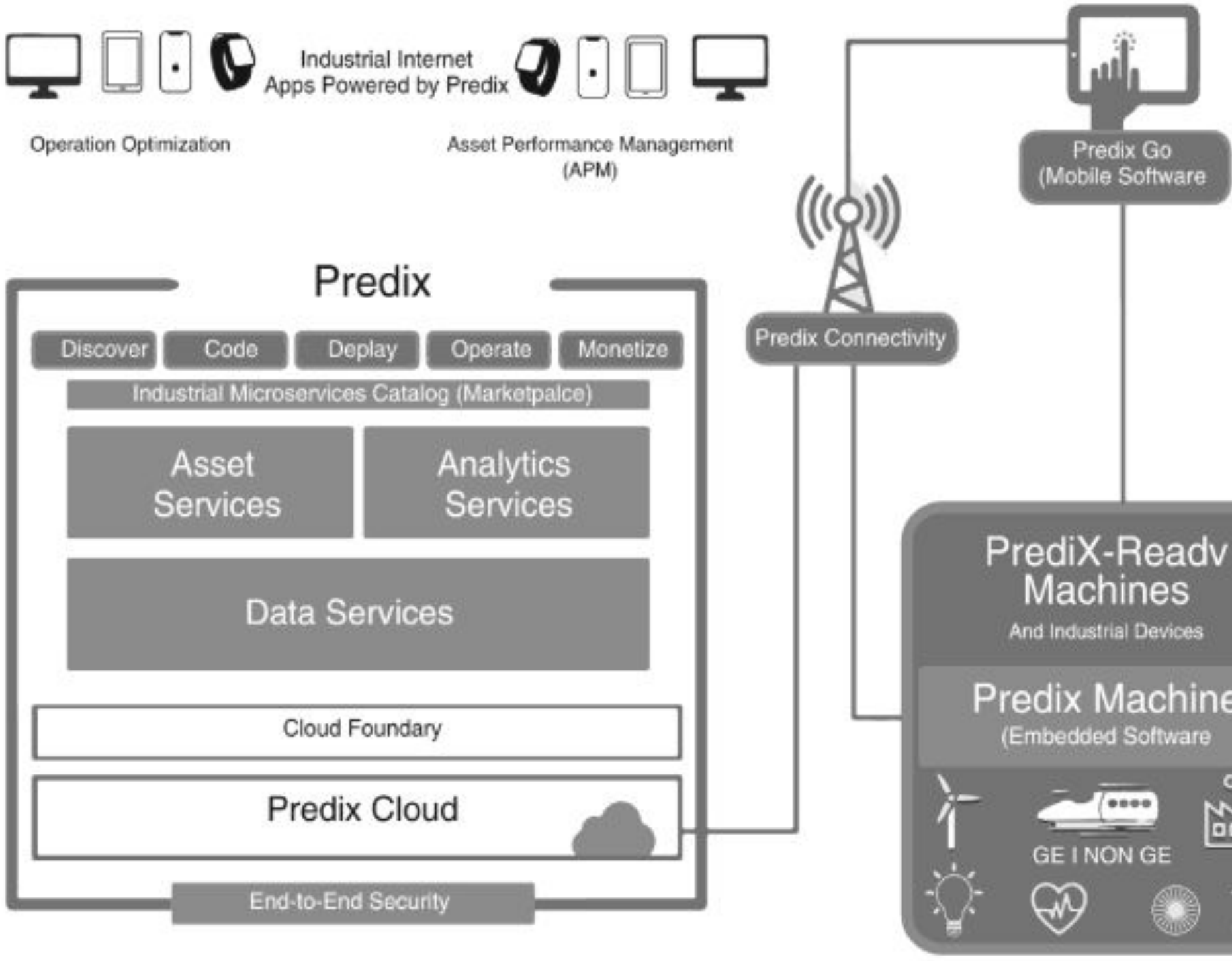
1. Unified integration components : IoT development to create easy and fast applications in on time

2. Platform offers multiple options for deployments including

- on-premises model
- Cloud model
- Hybrid model

3. UI : drag and drop tools, better user experience for non IT users

GE Predix


Industrial Internet
Apps Powered by Predix
Operation Optimization
Asset Performance Management
(APM)
Predix
Discover
Code
Deplay
Operate
Monetize
Industrial Microservices Catalog (Marketpalce)
Asset Services
Analytics Services
Data Services
Cloud Foundary
Predix Cloud
End-to-End Security
Predix Connectivity
Predix Go
(Mobile Software
PrediX-Readv Machines
And Industrial Devices
Predix Machine
(Embedded Software
GE I NON GE

GE Predix

Predix developed by General electric focus on factory centric environments.

an industrial IoT software platform from GE Digital.

It provides edge-to-cloud data connectivity, processing, analytics, and services to support industrial applications.

The Platform has both edge and cloud components.

Predix Cloud is hosted on AWS

Asset Performance Management (APM)

suite of software and services designed to help optimize asset performance and O&M efficiency across equipment, the plant and the entire fleet.

Featuring Digital Twin analytics, work process automation and built-in GE industry expertise

Operations Performance Management (OPM)

improves the performance of plants, sites, and generation portfolios with Performance Intelligence, Production Planning and Performance Optimization.

It supports innovative IoT solutions by providing a common software foundation for fundamental IoT security, scalability, and services functions.

GE Predix

By leveraging Amazon Web Services (AWS) while adding critical IoT functions, the Platform provides a common application foundation, shared user experience, rapid-time-to-value, and the customer economy of a purchase-once investment in secure and scalable IoT software infrastructure.

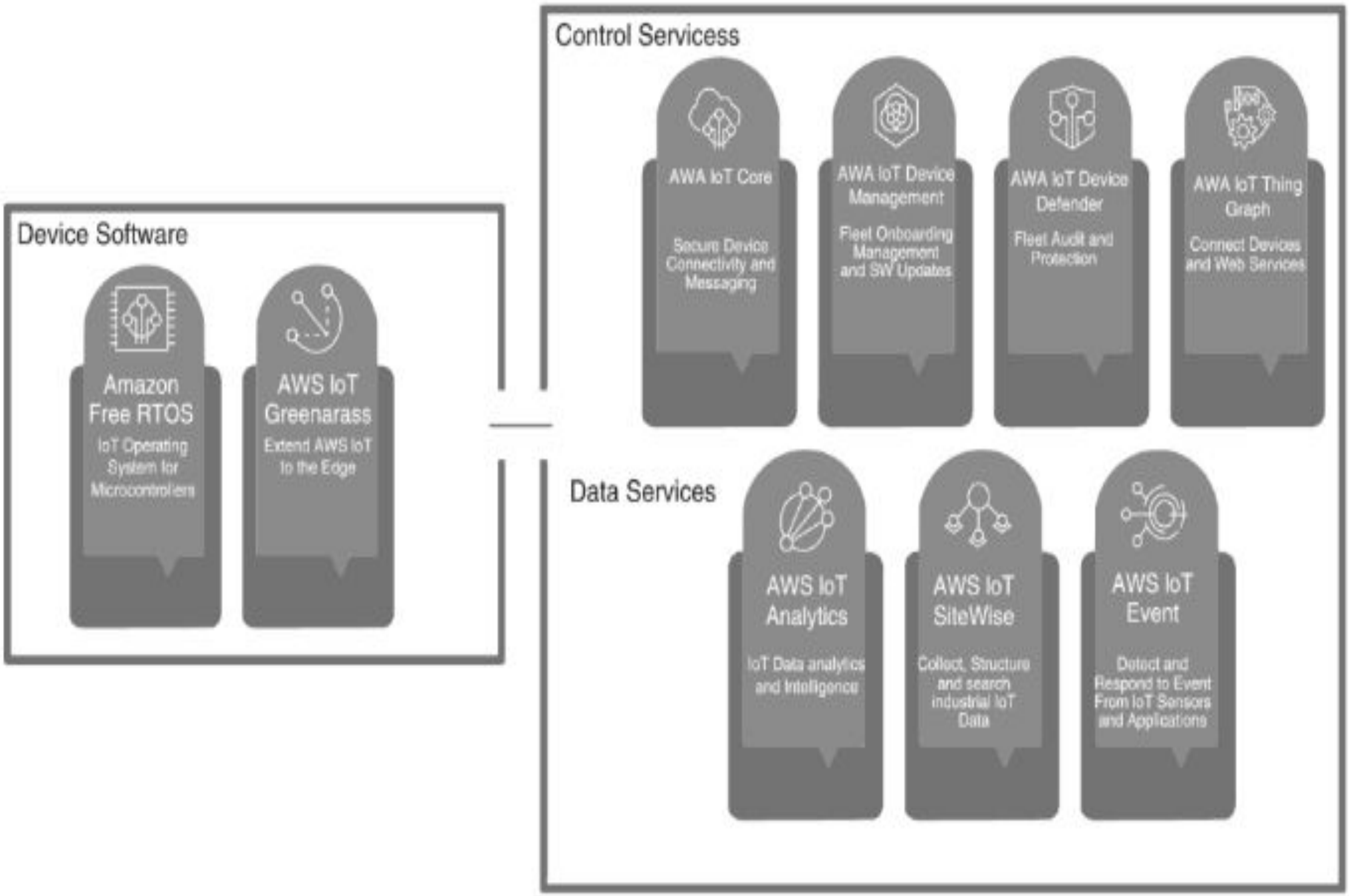
Platform Features

- IT/OT connectivity
- Data processing fabric
- Analytics execution
- Edge-to-cloud security
- Cloud scalability
- GE Digital application features

OT- Operational technology

refers to the hardware and software used to change, monitor, or control physical devices, processes, and events within a factory or production facility.

AWS IoT


Control Servicess
AWA IoT Core
Secure Device Connectivity and Messaging
AWA IoT Device Management
Fleet Onboarding Management and SW Updates
AWA IoT Device Defender
Fleet Audit and Protection
AWA IoT Thing Graph
Connect Devices and Web Services
Device Software
Amazon Free RTOS
IoT Operating System for Microcontrolers
AWS IoT Greenarass
Extend AWS IoT to the Edge
Data Services
AWS IoT Analytics
IoT Data analytics and Intelligence
AWS IoT SiteWise
Collect, Structure and search industrial IoT Data
AWS IoT Event
Detect and Respond to Event From IoT Sensors and Applications

AWS IoT: Key Components

Device Gateway

authorize the devices for efficient and secure communication with the AWS IoT Framework

Message Broker

safe medium for applications and device to send and receive messages

MQTT Protocol for subscription and publishing messages

HTTP Rest API used for publishing only

Rules Engine

Process of messages and integrates with other components of AWS

Rules give your devices the ability to interact with AWS services. Rules are analyzed and actions are performed based on the MQTT topic stream

Security and Identity Services

AWS IoT services address every layer of your application and device security.

Safeguard your device data with preventative mechanisms, like encryption and access control, and consistently audit and monitor your configurations with AWS IoT Device Defender.

AWS IoT: Key Components

Registry

Manages the resources of individual IoT enabled devices with the AWS cloud

Register the devices with maximum of 3 attributes

publish event messages when things, thing types, and thing groups are created, updated, or deleted.

Establishes an identity for devices and tracks metadata such as the devices' attributes and capabilities

Group Registry

Manages , supervising and handling many devices simultaneously

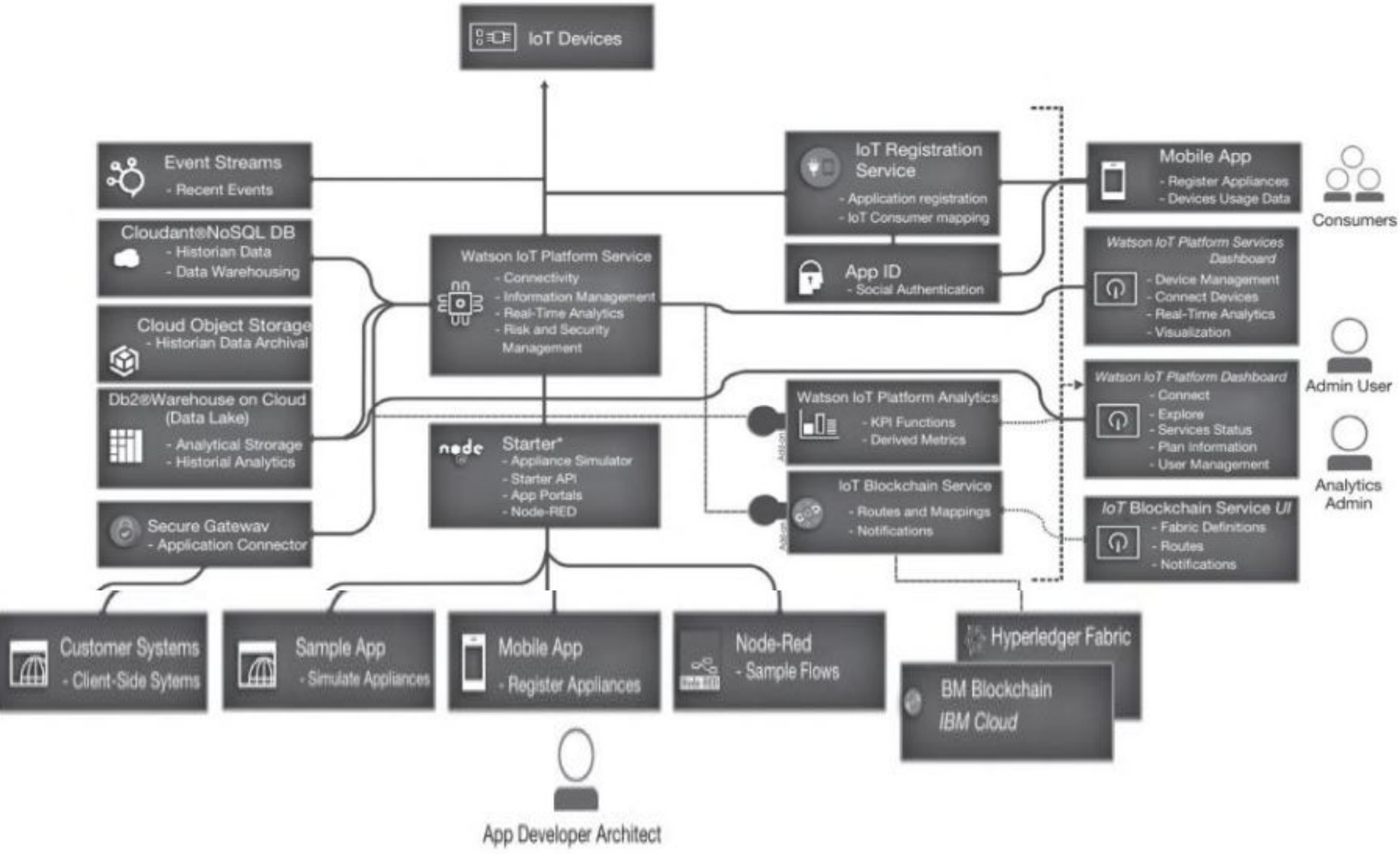
Devices are classified into groups according to their functions and characteristics.

A group may carry another group hence to create a hierarchy of groups.

Device Shadow

up to date data from IoT device are stored in JSON documents

Watson IoT Platform



Watson IoT Platform

collect connected device data and perform analytics on real-time data.

fully managed, Cloud-hosted service that provides device management capabilities as well as data collection and management in a time series format.

any type of IoT device that can communicate over MQTT or HTTP.

Messaging protocol for the Internet of Things (IoT) - MQTT

Connect: Connect devices and develop applications.

Information Management: Store, normalize, transform, and review device data and integrate your Watson IoT Platform with other services.

Analytics: Visualize real-time device data by using the Watson IoT Platform dashboard.

Risk Management: Configure secure connectivity and architecture with access control for users and applications.

Framework classifies into 2

Managed devices – inbuilt in device management agent

Agent – enables the devices to use the device management protocol to communicate with watson IOT platform device management services

Unmanaged devices

devices doesn't carry any device management agent. Communicate with Watson IoT – two way transmission of commands and events

Dosen't perform the following functions

execute operation related to device management

Forward request to device management

IoT Framework : KAA

allows you to manage configuration of the devices individually or at scale.

You can define configuration for a specific device or for a group of devices based on their individual characteristics, such as software version, location, or other attributes.

enables data management for connected objects and the backend infrastructure by providing the server and endpoint SDK components.

Features:

Hardware Integration

- Sensors , Gateways, Industrial PLC, Machines, Trucks, cars, ships
- Wearable & Smartphone

Analytics

Analyzed to large data sets with COT systems

Commercial-off-the-shelf (COTS) software is a term in software engineering for ready-made, commercial products.

Different data source can be imported and exported without any restrictions

IoT Framework : KAA

Device Management

Manage devices and their credentials individually or in groups.

Maintain a register of digital twins so all the device's data will be available even when it's offline.

provides a register of digital twins, which represent things, devices, and other entities managed by the platform.

Kaa also allows you to store device attributes, which provide more detailed information about any characteristic of the device.

Examples of such attributes could be a serial number, MAC address, location, software version, etc

To connect to the platform, a device has to present valid credentials, such as pre-shared keys, tokens, login and password combinations, certificates, etc.

IoT Framework : KAA

Connectivity

Connect devices directly or via gateways using all modern connectivity types

Use IoT protocols supported out-of-box (like MQTT) or implement platform's open interfaces to support a new protocol.

- Sigfox, LoRa, NB-IoT
- Near field (WiFi, BLE, Z-Wave)
- Cellular (2G/3G/4G/
- Wired (Ethernet)

Data Collections

Reliably collect data on a large scale.

Configure data processing pipelines.

Optimize network and battery use with batching.

collect both structured and unstructured data.

Kaa Enterprise IoT Platform is pre-integrated with production-ready databases like Cassandra, MongoDB, InfluxDB, and others.

IoT Framework : KAA

Configuration Management

for controlling the device behavior, managing data processing parameters, edge analytics, feature flagging, and other functions.

define configuration for a specific device or for a group of devices based on their individual characteristics, such as software version, location, or other attributes.

For example, you can configure an air conditioner with the desired temperature, set reporting period for a smart meter, etc.

Data Visualization

providing a view of data from IoT sensors

comprises a rich set of widgets, such as gauges, charts, maps, tables, etc.

widgets to visualize different types of data, whether telemetry, statistics, geolocation, metadata, filters, software updates, or other—both historical and current.

IoT Framework : KAA

Command Execution

allows you to deliver messages with the arbitrary payload to connected devices, execute commands, and receive near-real time responses.

For example, you can remotely check current temperature on a home thermostat, point a security camera to a specific area, open a vehicle trunk, and so on.

implements the two-way communication that allows devices to send a response back to the server. The caller can wait for the response either synchronously or asynchronously

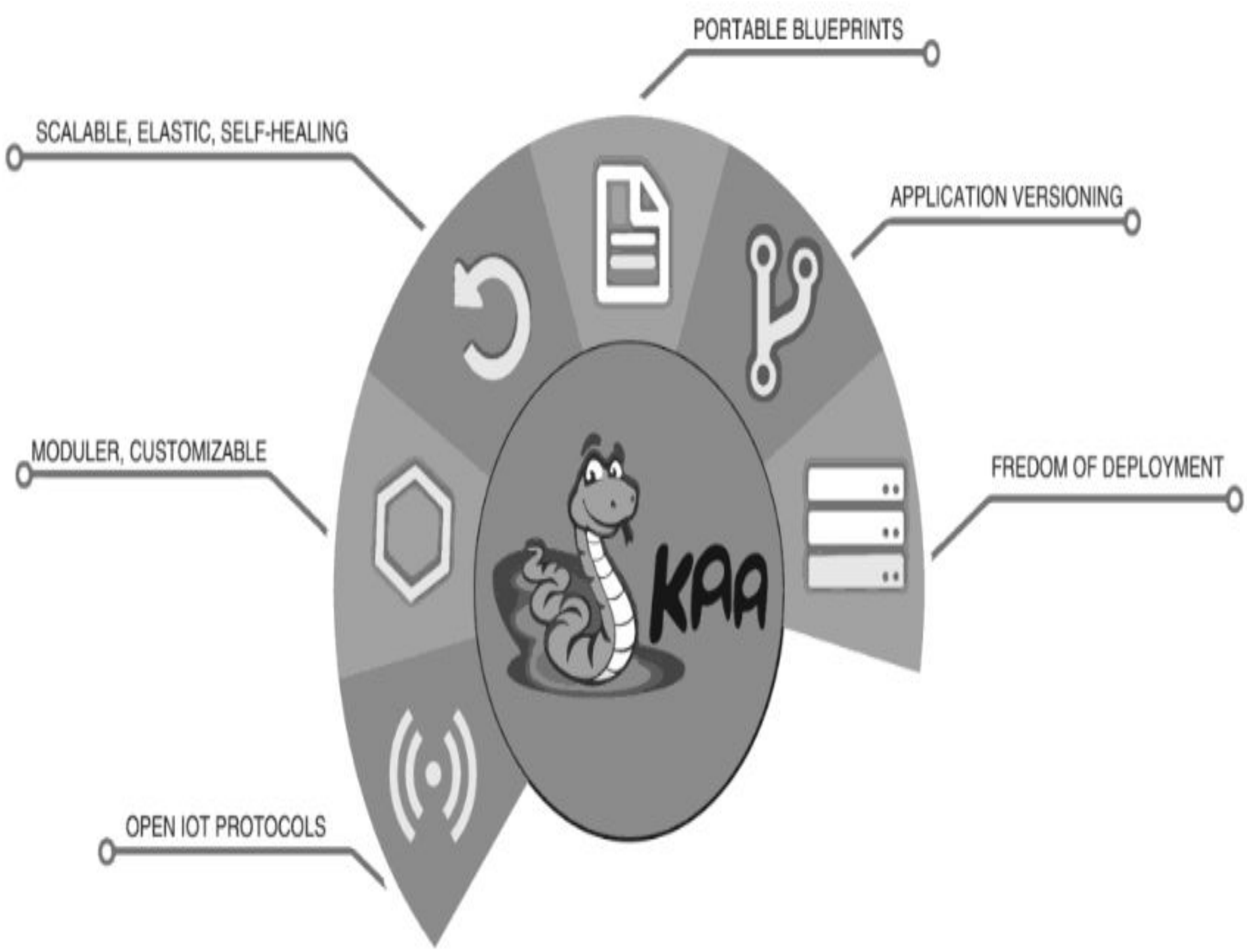
Updates

After you add a device to the Kaa platform, you can synchronize live and historical time series data

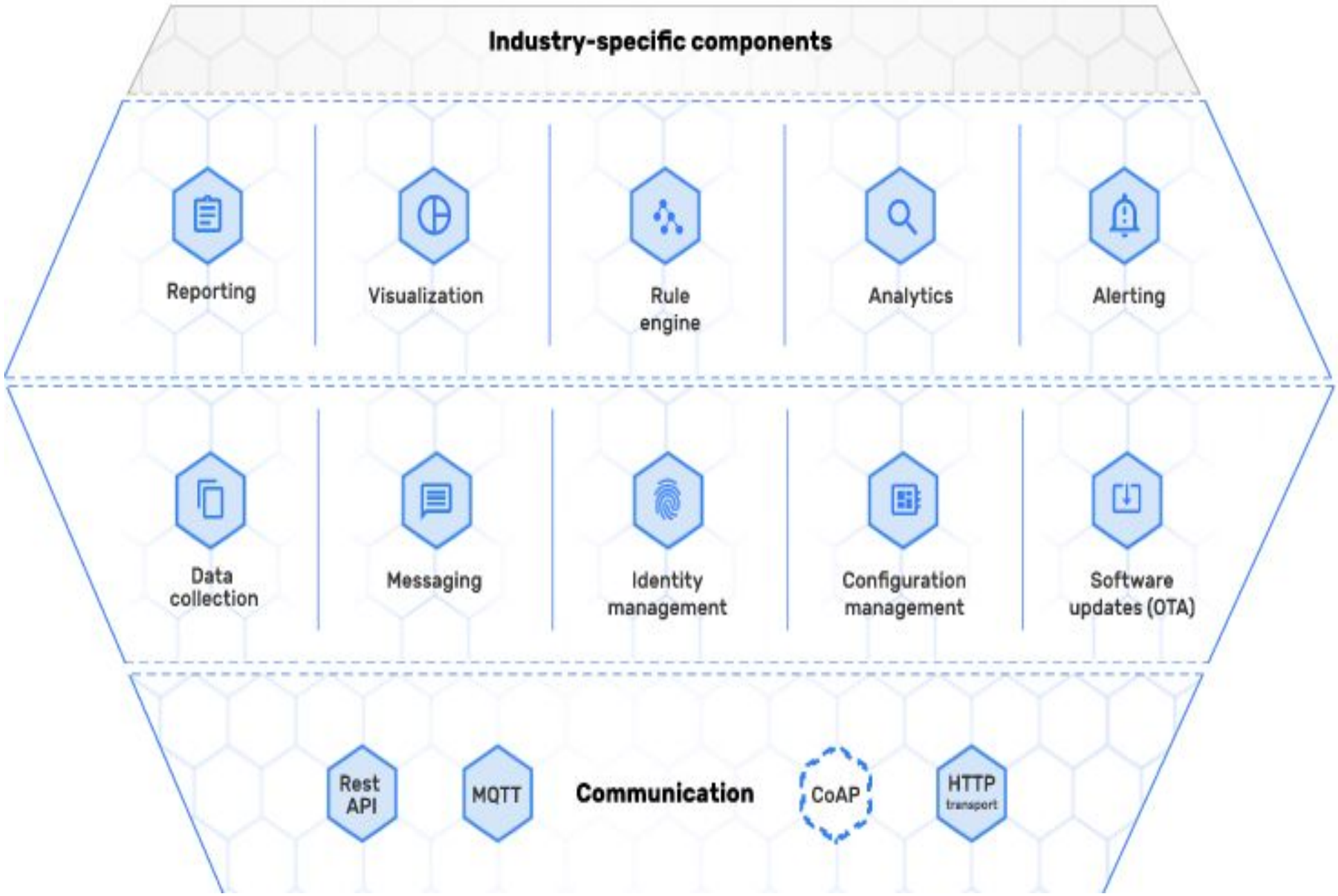
New upgrades can be added in IoT devices

All the version of software can be tracked, managed it easier to maintain

IoT Framework : KAA



IoT Framework : KAA



IoT Ecosystem

Major components

- Device
- Security
- Network
- Gateway
- Cloud
- Applications

the smarter devices send and receive data from the devices themselves in the environment that are integrate over network and Cloud Computing.

IoT Ecosystem : Devices & Sensors

The layer of sensors, actuators, and smart objects that gather information about the environment and measure physical parameters.

An actuator is **a machine component or system that moves or controls the mechanism or the system**.

to get information from the environment and transform it into data.

Different types of applications require different types of sensors to collect data from the environment. T

sensors and actuators are at the centre of the entire IoT network.

Sensors are connected to assets in the form of a physical micro appliance, embedded into an IoT device.

Sensors or device remain connected via wireless networks such as bluetooth, Z-wave, and WiFi

Temperature sensor, Proximity sensors, Water quality Sensor, Chemical Sensors, Humidity, Motion sensors, Pressure, Smoke, Image, Accelerometers, IR

IoT Ecosystem : Gateway

Acts as a medium to open up connection between cloud and controller(sensors / devices) in Internet of Things (IoT).

An IoT gateway is an intelligent central hub for IoT devices.

By the help of gateways it is possible to establish device to device or device to cloud communication. A gateway can be a typical hardware device or software program.

Performs protocol translation, aggregating all data, local processing and filtering of data before sending it to cloud, locally storing data and autonomously controlling devices based on some inputted data, providing additional device security.

Connectivity types include LPWAN, Wi-Fi, Bluetooth, and Zigbee, among many others.

Gateways can communicate with sensors/devices over varying connectivity types and then translate that data into a standard protocol such as MQTT to be sent to the cloud

designed to simplify and streamline IoT device communications and management.

IoT Ecosystem : Devices & Sensors

Key functionalities of IoT Gateway

- Establishing communication bridge
- Provides additional security.
- Performs data aggregation
- Pre processing and filtering of data.
- Provides local storage as a cache/ buffer.
- Data computing at edge level
- Ability to manage entire device.
- Device diagnostics
- Support for multiple connectivity protocols
- Verifying protocols.

IoT Ecosystem : Data capture done through IoT gateway

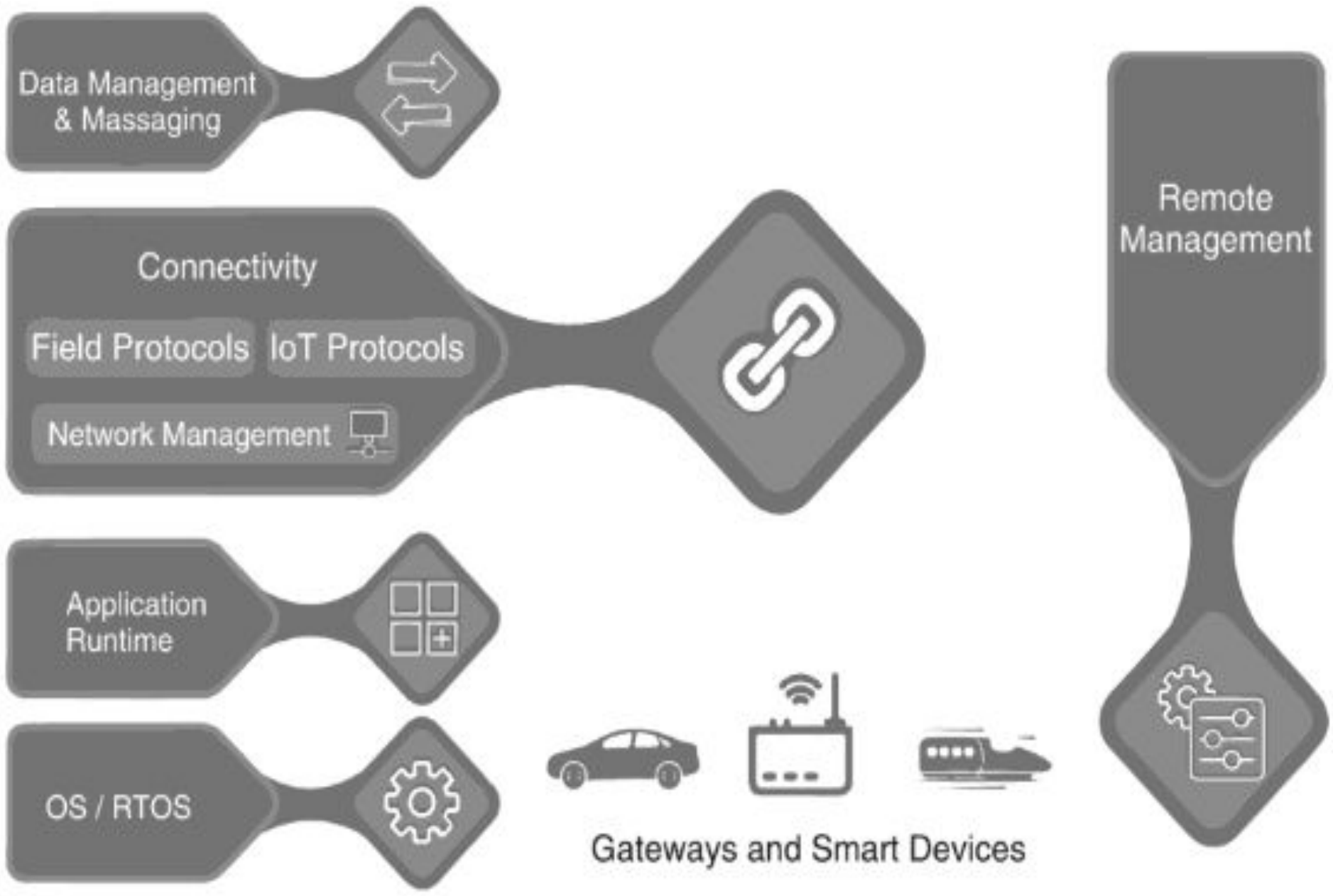
- The first requirement of an IoT Gateway is to discover and connect devices and collect data from those devices.
- Data provided by devices are generally continuous and has a tendency to occupy large communication bandwidth.

  Gateway provides bandwidth flexibility and data management that is necessary for evaluation of system performance and device control & management.
- Standards and protocols establish a bidirectional connection between devices and IoT gateway.

Gateway provides an end to end communication between edge and cloud.

- Gateway analyses data according to set parameters and accordingly conveys the message to the messaging interface for further control actions.

IoT Ecosystem : IoT gateway



IoT Ecosystem : Cloud

One component that improves the success of the Internet of Things is Cloud Computing.

activities like storage and data processing take place in the cloud rather than on the device itself,

Cloud computing enables users to perform computing tasks using services provided over the Internet.

sensor data can be uploaded and saved using cloud computing for later use as intelligent monitoring and activation using other devices.

Using the cloud also allows for high scalability.

When you have hundreds, thousands, or even millions of sensors, putting large amounts of computational power on each sensor would be extremely expensive and energy-intensive.

Instead, data can be passed to the cloud from all these sensors and processed there in aggregate.

IoT Ecosystem : Benefits And Functions of IoT Cloud

- IoT Cloud Computing provides many connectivity options, implying large network access.

Ex: mobile devices, tablets, laptops

- Developers can use IoT cloud computing on-demand.
- Based on the request, users can scale the service according to their needs.
- Cloud Computing implies the pooling of resources
- As the number of IoT devices and automation in use grows, security concerns emerge.
- pay for those resources that you use,

IoT Ecosystem : Analytics

IoT Analytics is used to make sense of the vast amounts of analog data.

Analytics requires storage power and intelligent computation to be able to make sense of any data

software systems that analyze the data generated by IoT devices.

IoT analytics assesses vast quantities of data and produces useful information from it.

Analysis can be used for a variety of use-cases, most common would be predictive maintenance.

Enables organisations to generate real-time insights that benefit them in the present, but also helps them to foresee future business trends in advance.

Predictive analytics(future), real-time analytics and descriptive analytics(Past data)

IoT Ecosystem : User Interface

The user interface is the visible component that is easily accessible and in control of the IoT user.

This is where a user can control the system and set their preferences.

A user may interact with the system via the device itself, or this interaction can be conducted remotely via smartphones, tablets, and laptops.

Smart home systems such as Amazon Alexa or Google Home etc. also allow users to communicate with their “things”.

Elements for IoT Implementation

Security

The act of securing Internet devices and the networks they're connected to from threats and breaches by protecting, identifying, and monitoring risks all while helping fix vulnerabilities from a range of devices that can pose security risks to your business.

IoT security is the process of securing these devices and ensuring they do not introduce threats into a network.

Without security for IoT, any connected object, from refrigerators to manufacturing bots, can be hacked. Once hackers gain control, they can usurp the object's functionality and steal the user's digital data.

Data Sensitivity

Data was collected from clients and processed for multiple purposes where the client had no idea about if his personal and sensitive details were misused

What type of data are the IoT sensor and equipment gathering?
How is the data going to be securely stored ?
What are the users in the organization that have the required access to this data ?
How will the integrated components of the ecosystem process the data ?

Elements for IoT Implementation

Scalability

Auto scalability

Data is another factor which will grow exponentially.

IoT applications must have the ability to support an increasing number of connected devices, users, application features, and analytics capabilities, without any degradation in the quality of service.

AI

Data is analyzed and provide suggestion and recommendation to customer

Uses neural network, computer vision, natural language processing

Interoperability

The capacity for multiple components within an IoT deployment to effectively communicate, share data and perform together to achieve a shared outcome.

Organizations must be able to transmit and understand data throughout all the connections from devices to the cloud.

E-Health with Internet of Things

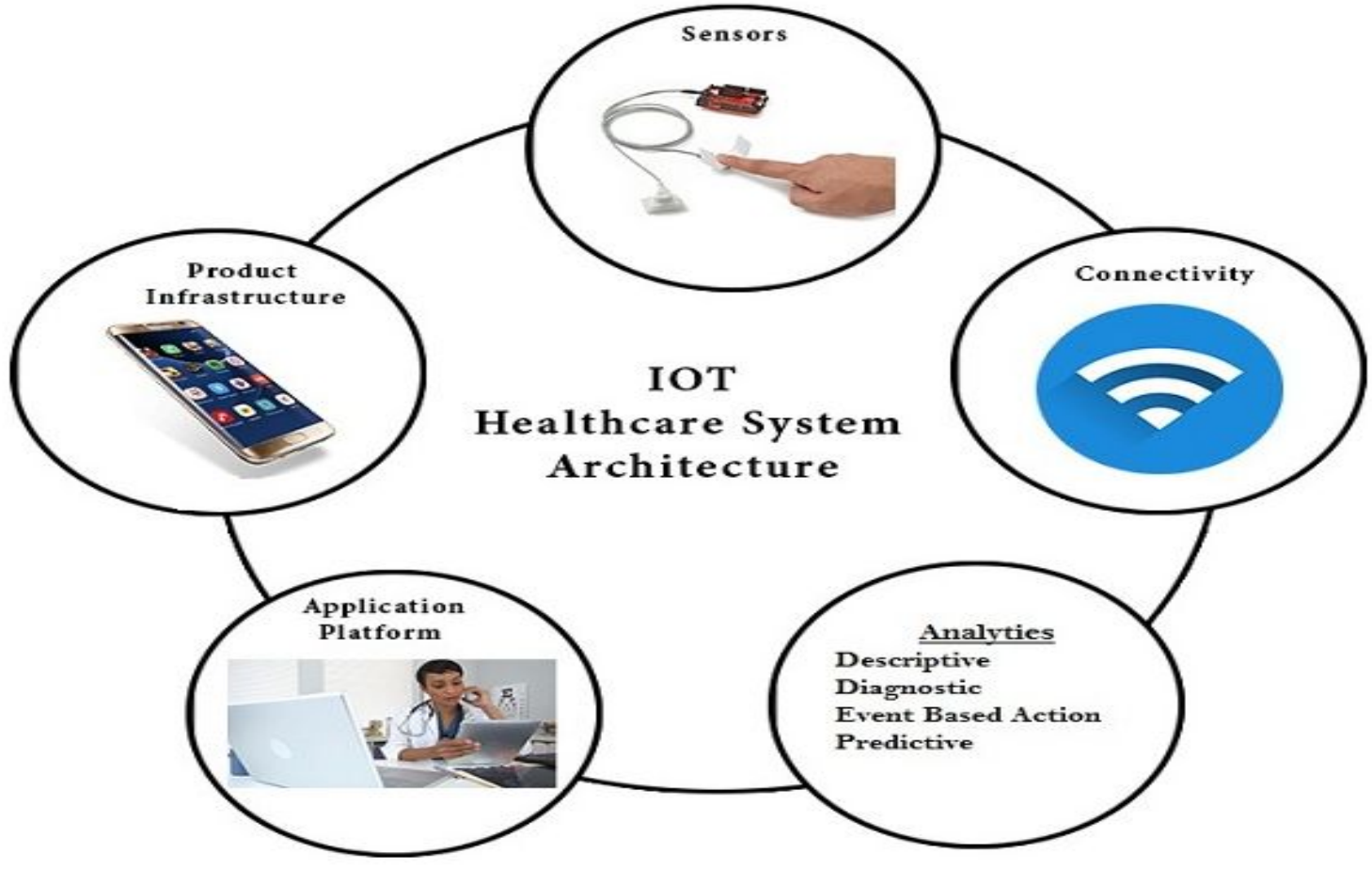
IOT as a key in Digital Health Care System

made remote monitoring in the healthcare sector possible, unleashing the potential to keep patients safe and healthy, and empowering physicians to deliver superlative care.

It keeps the patients safe and healthy as well as improves the physician delivers care towards the patients.

The system can be used for monitoring vital parameters. **data, such as: blood pressure, heart rate, body temperature, respiratory flow, glucose, weight etc**

Healthcare devices collect diverse data from a large set of real-world cases that increases the accuracy and the size of medical data



Applications of IoT technology in health and healthcare

Glucose Monitoring Systems

Heart Monitor and Reporting

Ingestible Sensors

Pills have been created to which the patients need to swallow it and it dissolves in stomach. That Pill contains sensors which can tell right medicines have been taken at right time through mobile app alert.

Wireless Temperature sensors

Smart dustbins

It automatically opens and closes accordingly as per requirement keeping all safe.

Asthma Monitor Inhalers

Device Monitoring

Many times some clinical equipment or materials are misplaced so that it creates to get it at the right time.

Step monitoring and reporting

To make the people to walk everyday and keeping track on number of steps

Smart Saline Solution

IoT enabled saline solution keeps track on the saline water automatically and when ever it is needed to refill it informs the medical staffs that particular saline is going to empty and needs refill making the things easy.

Depression and mood monitoring

By collecting and analyzing data such as heart rate and blood pressure, devices can infer information about a patient's mental state.

Advanced IoT devices for mood monitoring can even track data such as the movement of a patient's eyes.

IoT Ecosystem : Devices & Sensors

Robots in health care

fill the place of nurses or other medical staffs

Connected contact lenses

restore the eye's focus and improve vision.

Patient monitoring from home

eveloped to monitor the patient and their surrounding for the betterment of patients. Medical professional will be alerted if anything wrong happens or any critical situation arises.

EMR

a digital version of paper-based medical file records of an individual. EMR systems help to provide quick access to health care information remotely, at anytime and anywhere with the availability of IoT technology.

Advantages of IoT in healthcare

Cost Reduction

IoT enables patient monitoring in real time, thus significantly cutting down unnecessary visits to doctors, hospital stays and re-admissions

Improved Treatment

It enables physicians to make evidence-based informed decisions and brings absolute transparency

Faster Disease Diagnosis

Continuous patient monitoring and real time data helps in diagnosing diseases at an early stage or even before the disease develops based on symptoms

Proactive Treatment

Continuous health monitoring opens the doors for providing proactive medical treatment

Drugs and Equipment Management

Management of drugs and medical equipment is a major challenge in a healthcare industry. Through connected devices, these are managed and utilized efficiently with reduced costs

Error Reduction

Data generated through IoT devices not only help in effective decision making but also ensure smooth healthcare operations with reduced errors, waste and system costs

Environmental Monitoring with Internet of Things

It **uses advanced sensor devices to identify the presence of pollutants in the air and water and promotes better sustainability**

four types of environmental monitoring: **air quality, water quality, noise quality, and biodiversity**.

Water Quality Monitoring

Water quality monitoring using IoT-based systems helps to control contamination and support management of this valuable resource.

Using IoT systems allows water to be analyzed in buildings, water and wastewater plants, irrigation systems and industrial processes.

Accurate measurements of contaminants, oxygen levels, additional factors, and pH levels.

IoT technology allows the detection of harmful substances public it reaches homes and buildings.

Some examples include:Municipal water treatment monitoring

Stormwater and groundwater monitoring

Agricultural irrigation monitoring and control

City water and drinking water quality monitoring

Environmental Monitoring with Internet of Things

Air Quality Monitoring

Industrial processes emit organic compounds like carbon monoxide, hydrocarbons, and chemicals ("greenhouse gases") into the air.

exhaust from vehicles and methane from cattle impact the quality of our air and impact our planet.

With air quality monitoring, science and industry can create change.

These critical metrics deliver the insights for municipalities to make decisions for urban planning, for industrial operations to mitigate their impact, and for entire auto makers to continually improve designs to reduce emissions.

Even deploying IoT to manage traffic flow in cities can massively reduce vehicle emissions and support cleaner air.

Some real-world examples of air quality monitoring include:

Carbon monoxide monitoring in homes and buildings

Methane monitoring in agriculture and waste management

Ambient air quality monitoring for pollutants, lead and toxic particulates

Environmental Monitoring with Internet of Things

Energy Monitoring

energy monitoring is essential to conservation.

IoT-based technologies can provide both the management tools and the insights to improve how we use energy.

Energy monitoring supports numerous *energy management goals*:

Reduction in the use of fossil fuels in homes and businesses

Stabilizing the power grid

Preventing spikes in energy usage, and associated equipment failures and service disruption

Toxic Gas Detection

Toxic gas detection systems analyze air quality in a range of industrial operations to detect harmful, toxic, and flammable gases present in the atmosphere

Enabling us to identify contaminants before they cause environmental damage or harm to human health.

IoT connectivity enables these systems to quickly provide critical alerts and to launch tasks such as shutting off valves, shutting down systems and launching fire alarms and chemical mitigation systems.

Environmental Monitoring with Internet of Things