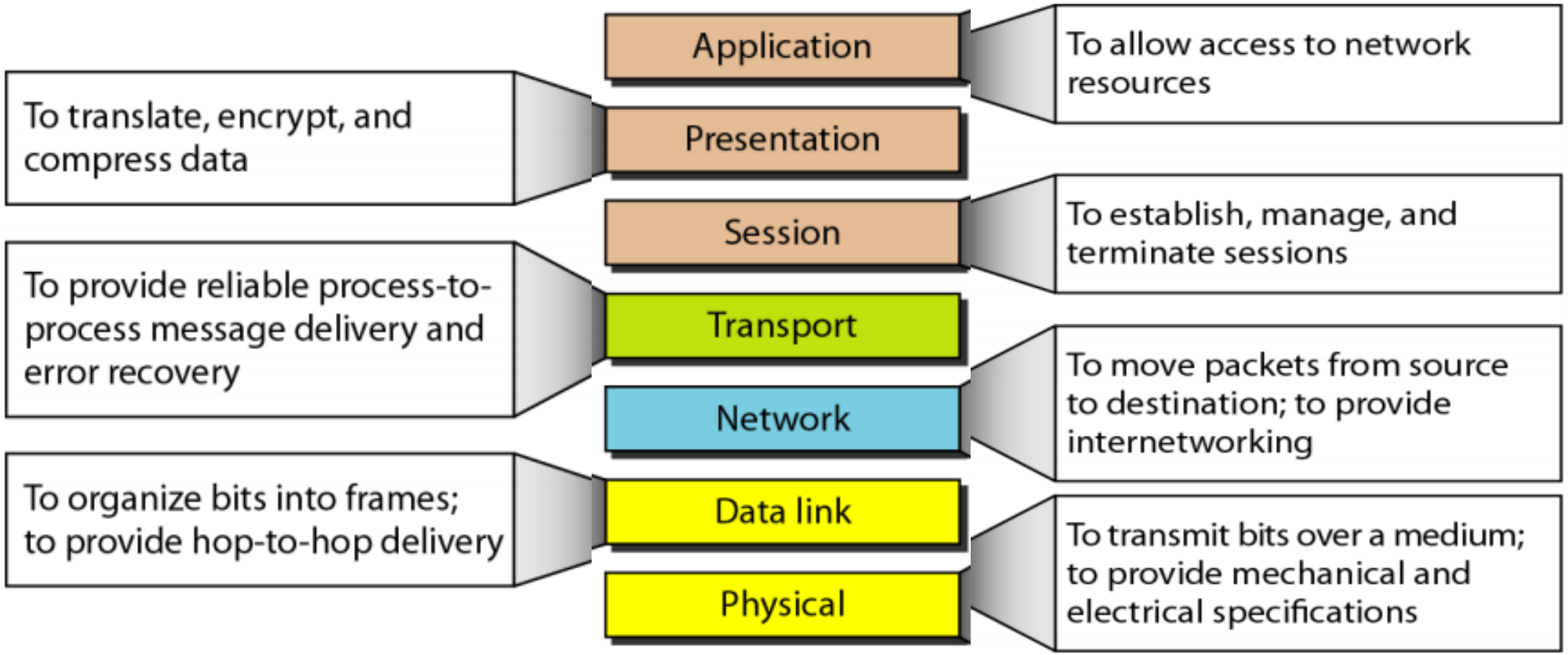
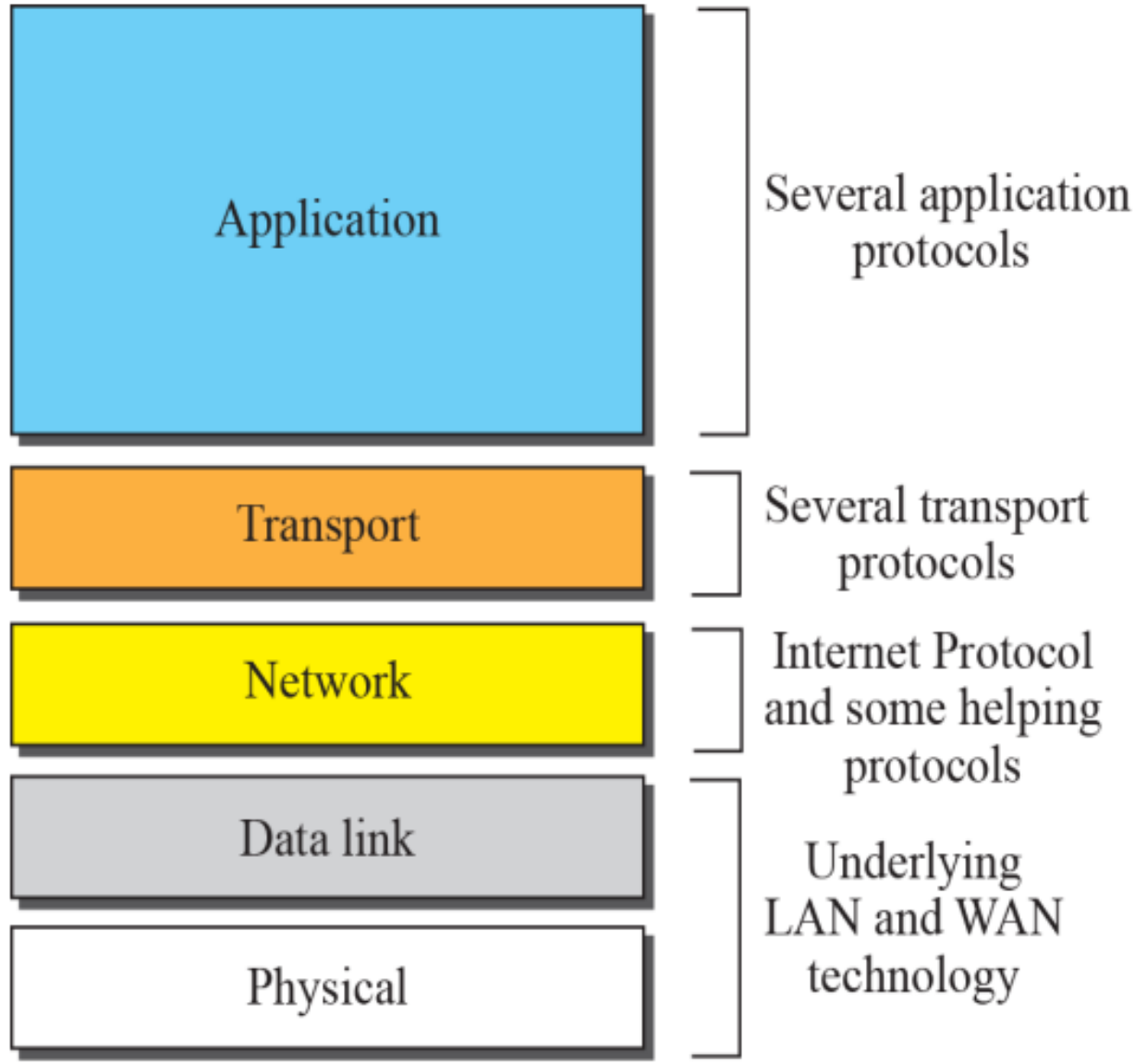
IoT Protocol and Communication Model IoT Level

Network OSI Model



TCP/IP Protocol



TCP/IP Protocol Suite

IoT Protocol

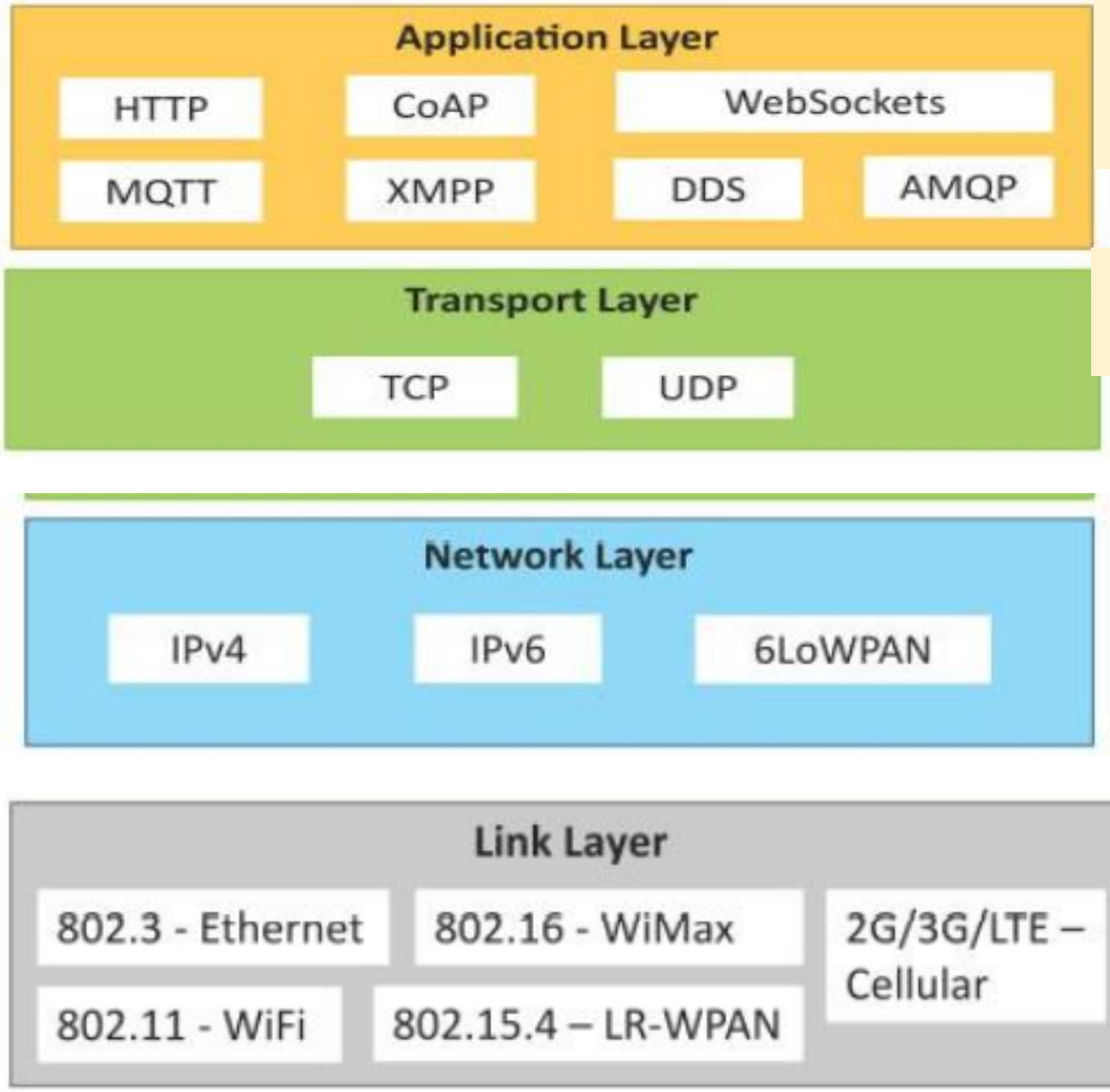
IoT Protocol

- IoT protocols enable it to **exchange data** in a structured and meaningful way.
- IoT protocols serves a platform that the IoT devices (gear uses) in order to **communicate**.

- Link Layer
  - 802.3 – Ethernet
  - 802.11 – WiFi
  - 802.16 – WiMax
  - 802.15.4 – LR-WPAN
  - 2G/3G/4G
- Network/Internet Layer
  - IPv4
  - IPv6
  - 6LoWPAN
- Transport Layer
  - TCP
  - UDP
- Application Layer
  - HTTP
  - CoAP
  - WebSocket
  - MQTT
  - XMPP
  - DDS
  - AMQP

Constrained Application Protocol

Extensible Messaging and Presence Protocol



Data-Distribution Service

Message Queuing Telemetry Transport

Advanced Message Queuing Protocol

IPv6 over Low - Power Wireless Personal Area Networks

1. Link Layer

Link Layer determines how the data is physically sent over the network's physical layer.

Ex: copper wire, OFC, radio waves etc.

Some examples are provided below:

802.3 - Ethernet

- Coaxial cables, twisted pair wire or optical fibre as a medium
- 10Mbps to 40Gbps+ data rate

802.3 – Coaxial cable

802.3 i – Copper twisted pair connections

802.3 j – Fibre optics connections

802.3 ae – Fibre

so on.....

Data rate- 10 MB/s to 40Gb/s

802.11 – Wi-Fi

- Wireless LAN;
- 802.11 b/g/n
- 2.4GHz / 5GHz band
- 1 Mbps to up to 6.75 Gbps data rate

802.11a – operates at 5GHz

802.11b/g - operates at 2.4GHz

802.11n - operates at 2.4/5GHz

802.11ac - operates at 5GHz

802.11ad - operates at 60GHz

Data rate- 1 Mb/s to 6.75 Gb/s

802.16 – WiMax

- Collection of wireless broadband standards
- 1.5Mbps to 1Gbps data rate

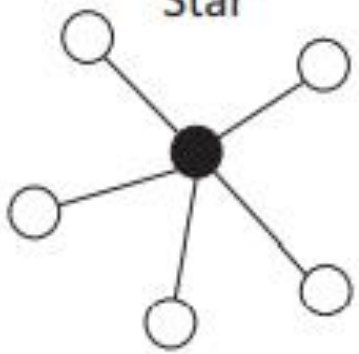
802.15.4 – LR-WPAN

- Low-rate wireless personal area networks

  ex: LoRa
- 40bps to 250Kbps data rate
- Provides low-cost, low-speed communication for low-power devices

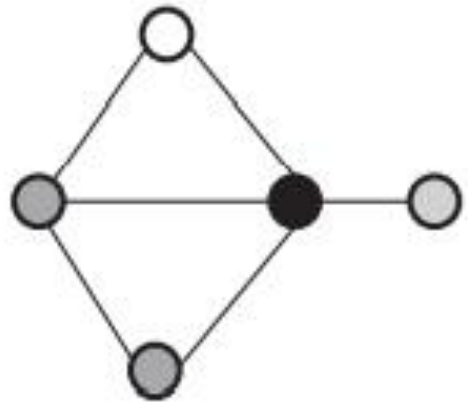
802.15.4 - LR-WPAN

Star



For power Constrained devices

Peer-to-peer



PAN Coordinator

FFD

RFD

Data rates - 40 kb/s to 250 kb/s

2G/3G/4G - Mobile Communication

- Data rates from 9.6Kbps (2G) to up to 100Mbps (4G).

2G - GSM and CDMA

3G - UMTS and CDMA2000

4G - LTE

Date rates - 9.6 kb/s to 100 mb/s

2. Network Layer

The Network layer is responsible for sending IP datagram from a source network to the destination network. The layer performs host addressing and packet routing.

Some examples are provided below:

Ipv4

- 32 bit address scheme. Total $(2)^{32}$ addresses are available

Network Layer

Ipv4

An Ipv4 address (dotted-decimal notation)

172 . 16 . 254 . 1

10101100.00010000.11111110.00000001

one byte = Eight bytes

Thirtytwo bits (4x8), or 4 bytes

32 – bit addressing

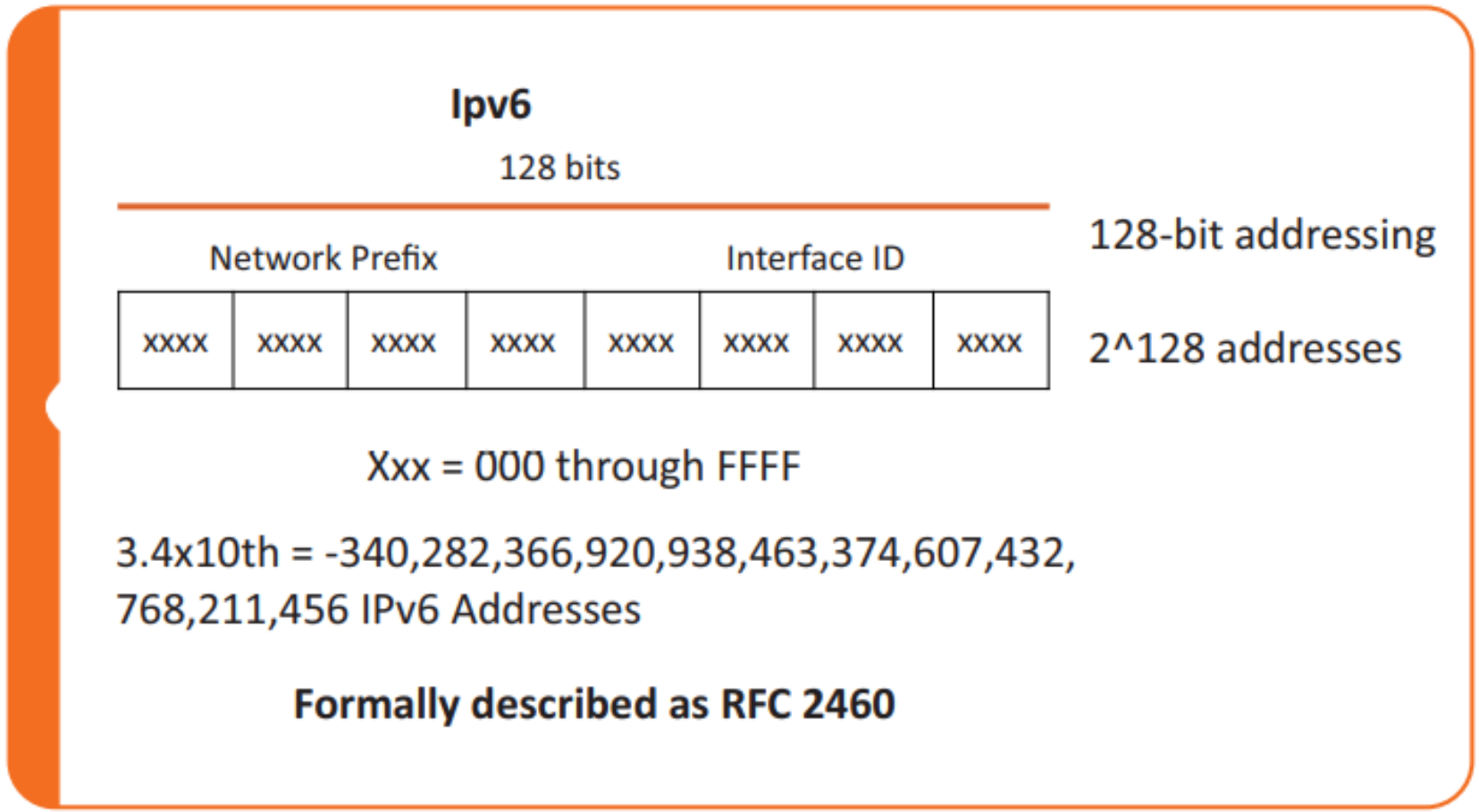
Addresses got exhausted in 2011

Guaranteed Delivery and data integrity handled by upper layer protocols e.g. TCP

Formally described as RFC 791

IPv6

- 128 bit address scheme. Total $(2)^{128}$ addresses are available



6LoWPAN

- IPv6 over Low power Wireless Personal Area Network
- Operates in 2.4GHz range with data transfer rate of 250Kbps

6LoWPAN

Low power Devices With limited Processing Capabilities

Transfer rate – 250 kb/s

Frequency – 2.4 Ghz

Works With 802.15.4.4 link layer protocols

3. Transport Layer

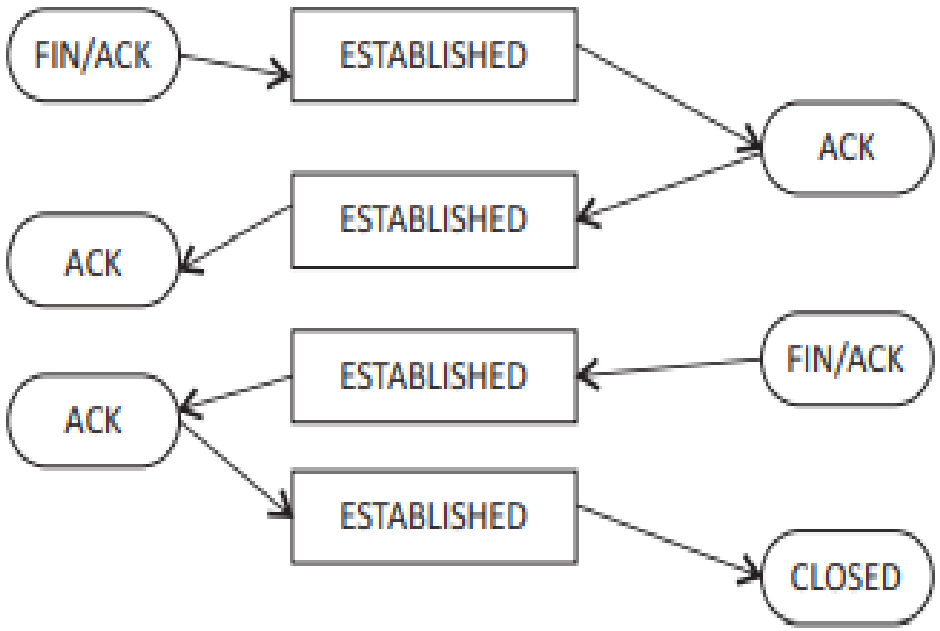
Transport layer protocols provide end-to-end message transfer capability independent of the underlying network.

TCP

- Transmission Control Protocol
- Connection oriented and state full protocol
- Ensures reliable transmission, provides error detection, flow control and congestion control

Transport Layer

TCP



Most widely used transport layer Protocols

Ensures reliable transmission of packets in-order

Helps avoiding network congestion and congestion collapse

UDP

- User Datagram Protocol
- Connectionless and stateless protocol
- Asynchronous protocol

UDP

Connectionless protocol

Time sensitive application

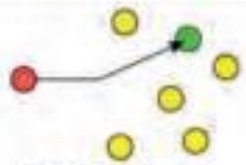
Transaction oriented and stateless protocol

NO guaranteed delivery

Comparison

TCP

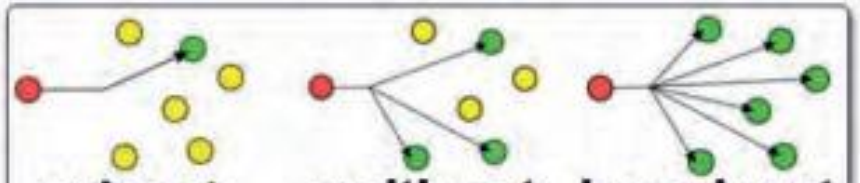
- **Slower but reliable transfers**
- **Typical applications:**
  - Email
  - Web browsing



unicast

UDP

- **Fast but non-guaranteed transfers ("best effort")**
- **Typical applications:**
  - VoIP
  - Music streaming



unicast **multicast** **broadcast**

4. Application Layer

Application layer protocol defines how the applications interface with lower layer protocols to send data over a network.

HTTP

- Hypertext Transfer Protocol
- Follows a request-response model

Constrained Application Protocol (CoAP)

- **Freely** available and usable for **any IoT** device
- Designed to address the needs of **HTTP-based IoT systems**
- CoAP relies on the User Datagram Protocol (**UDP**) for establishing **secure communication** between endpoints.
- CoAP features Quality of Service (with acknowledgement mg)
- CoAP fully addresses the needs of an **extremely light protocol** in order to meet the demands of **battery-operated or low-energy devices**.
- CoAP is a good match for **web service-based IoT systems**.

Message Queuing Telemetry Transport (MQTT)

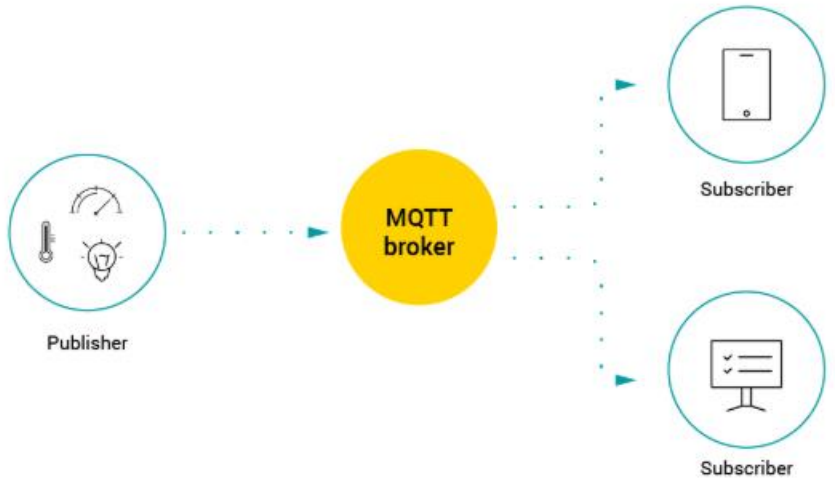
- Widely adopted standard in the **Industrial Internet of Things (IIoT)**
- MQTT's architecture is simple and lightweight **publication/subscription** type (pub/sub) messaging protocol
- Designed for **battery-powered devices**
- MQTT is based on subscriber, publisher and broker model

Features are :

•Minimum bandwidth use and wireless networks

•Low energy consumption Good reliability

•Little processing and memory resources



Extensible Messaging and Presence Protocol (XMPP)

- Developed by **open source** community
- IoT protocol for **message-oriented** middleware is based on the XML language
- Allows for real-time exchange of **structured** but extensible data between two or more network clients

- **Draw Back:**
  - No Quality of Service
  - No end-to-end encryption.

Data-Distribution Service (DDS)

- Falls under **publish-subscribe** methodology.
- Designed by the Object Management Group (OMG)
- For real-time M2M communication enables
  - **scalable,**
  - **Reliable**
  - **high-performance and interoperable data exchange between connected devices independent of the hardware and the software platform**

Application of DDS

- In Industrial Internet of Things deployments, such as
  - **air-traffic control,**
  - **smart grid management,**
  - **autonomous vehicles,**
  - **transportation systems,**
  - **robotics,**
  - **power generation,**
  - **healthcare services**.

Overall, DDS can be used for the management of data exchange between lightweight devices and interconnection of large, high-performance sensor networks.

Advanced Message Queuing Protocol (AMQP)

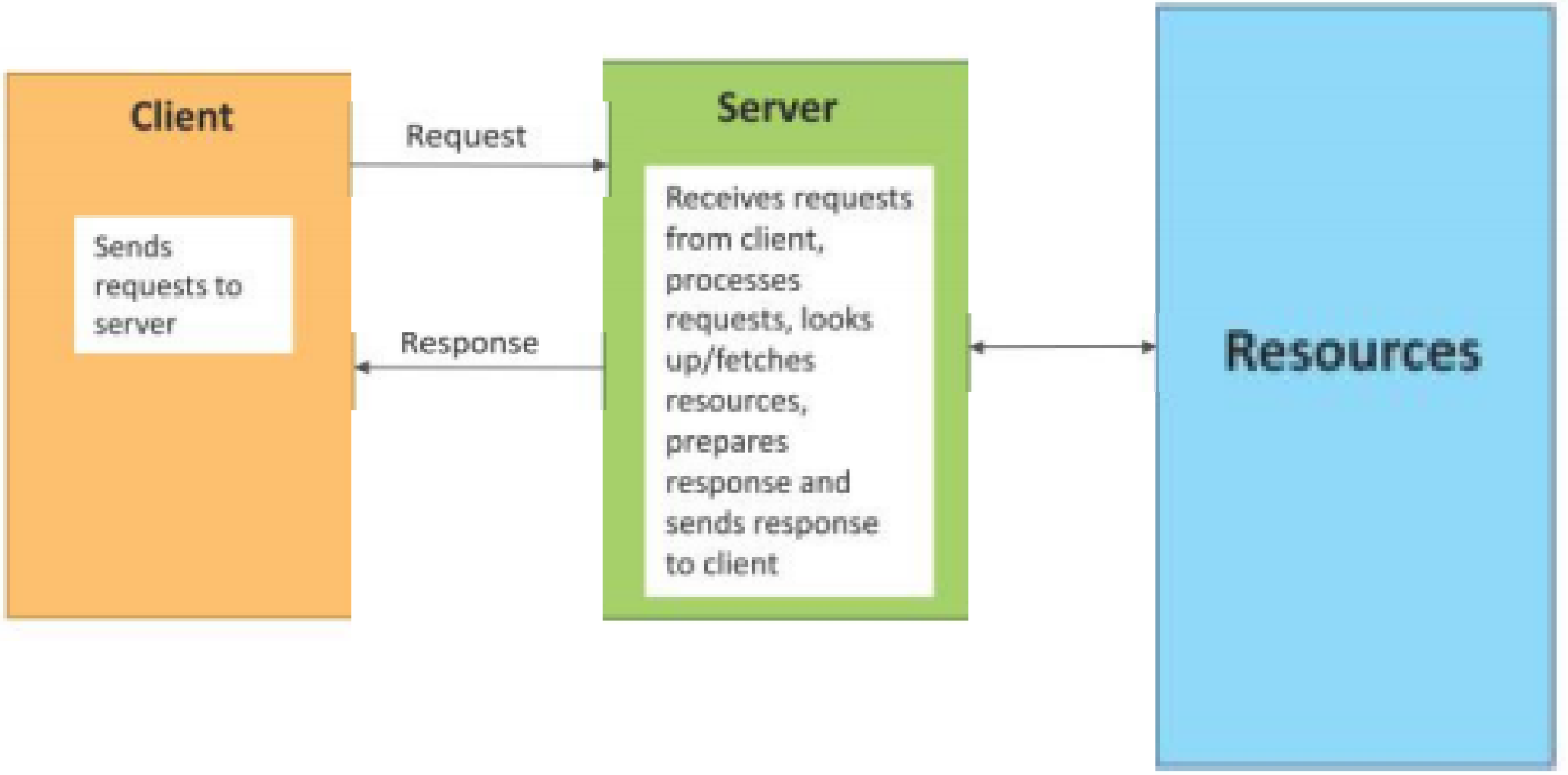
- Open standard **publish/subscribe** type protocol
- Its roots in the **financial services** sector.
- features as
  - **message orientation,**
  - **queuing,**
  - **routing (including point-to-point and publish-and-subscribe),**
  - **reliability and security.**
- AMQP can guarantee **complete transactions**

Limitation

- Due to its **heaviness**, AMQP is not suitable:
- Sensor devices
  - with limited memory,
  - power
  - network bandwidth

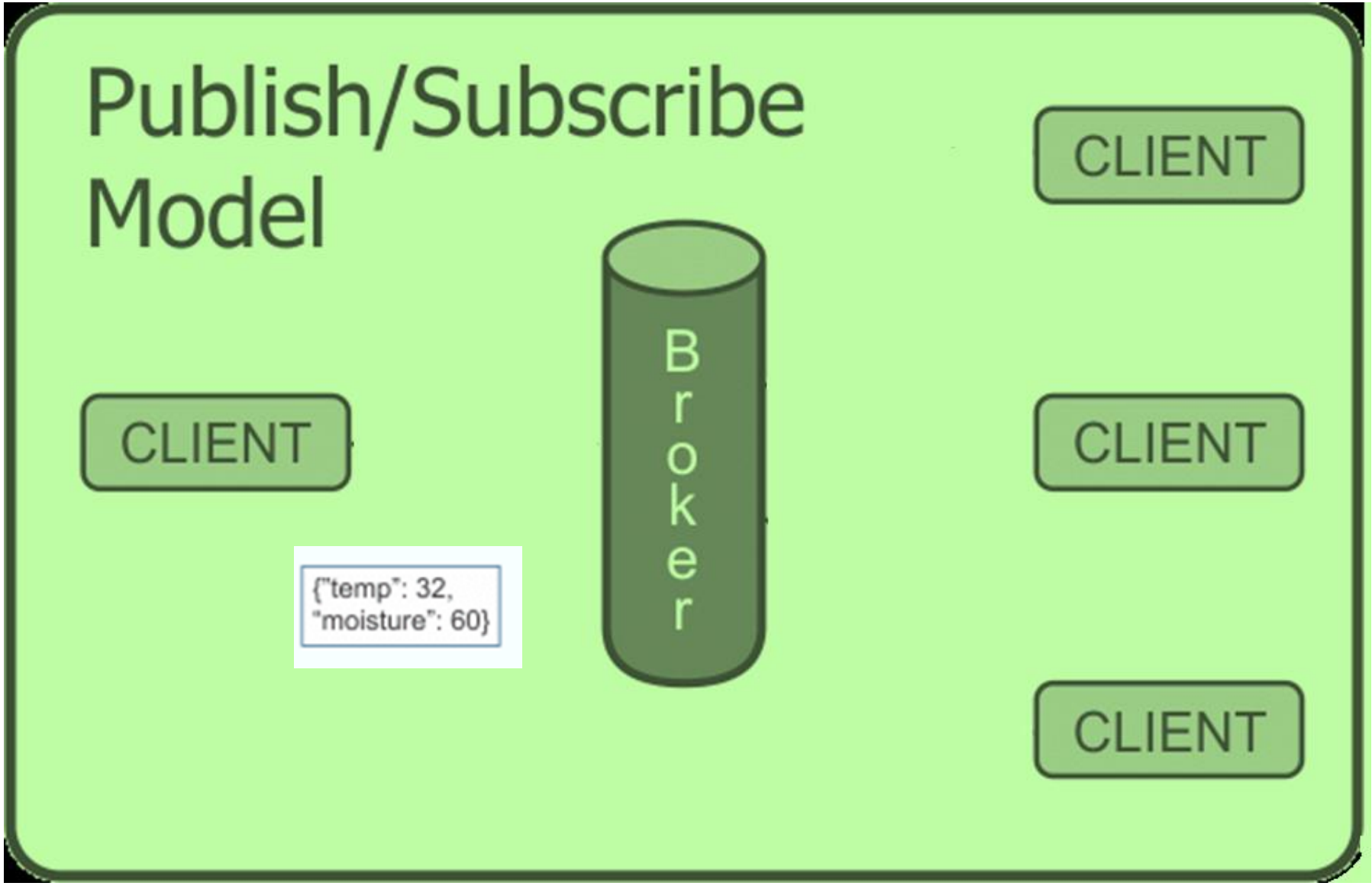
IoT Communication Models

Request-Response communication model

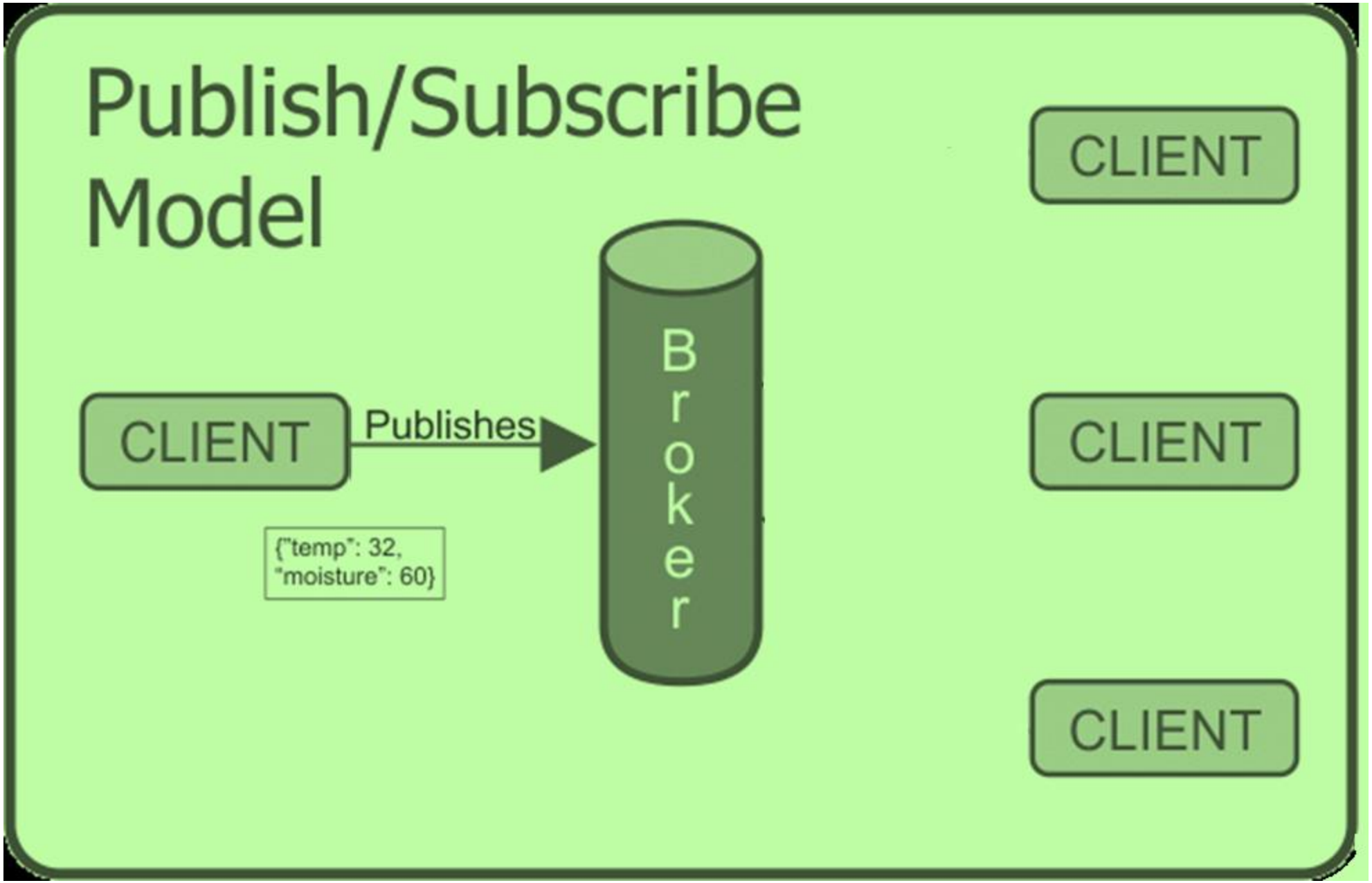


Request-Response communication model

- Request-Response is a communication model in which the client sends requests to the server and the server responds to the requests
- When the server receives a request, it decides how to respond, fetches the data, retrieves resource representations, prepares the response, and then sends the response to the client.



Source: https://www.researchgate.net/publication/327661439_The_Addition_of_Geolocation_to_Sensor_Networks/figures?lo=1



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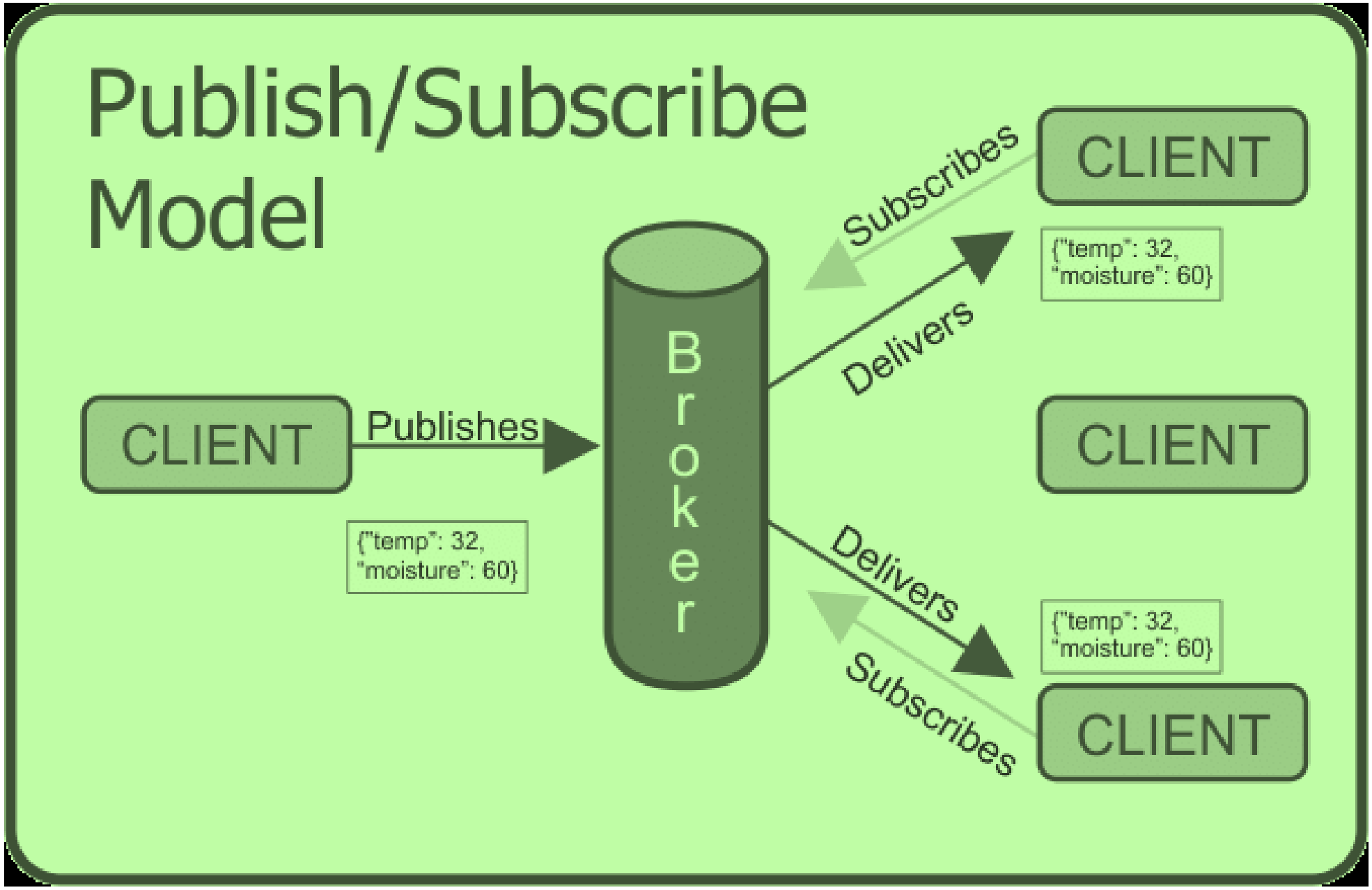

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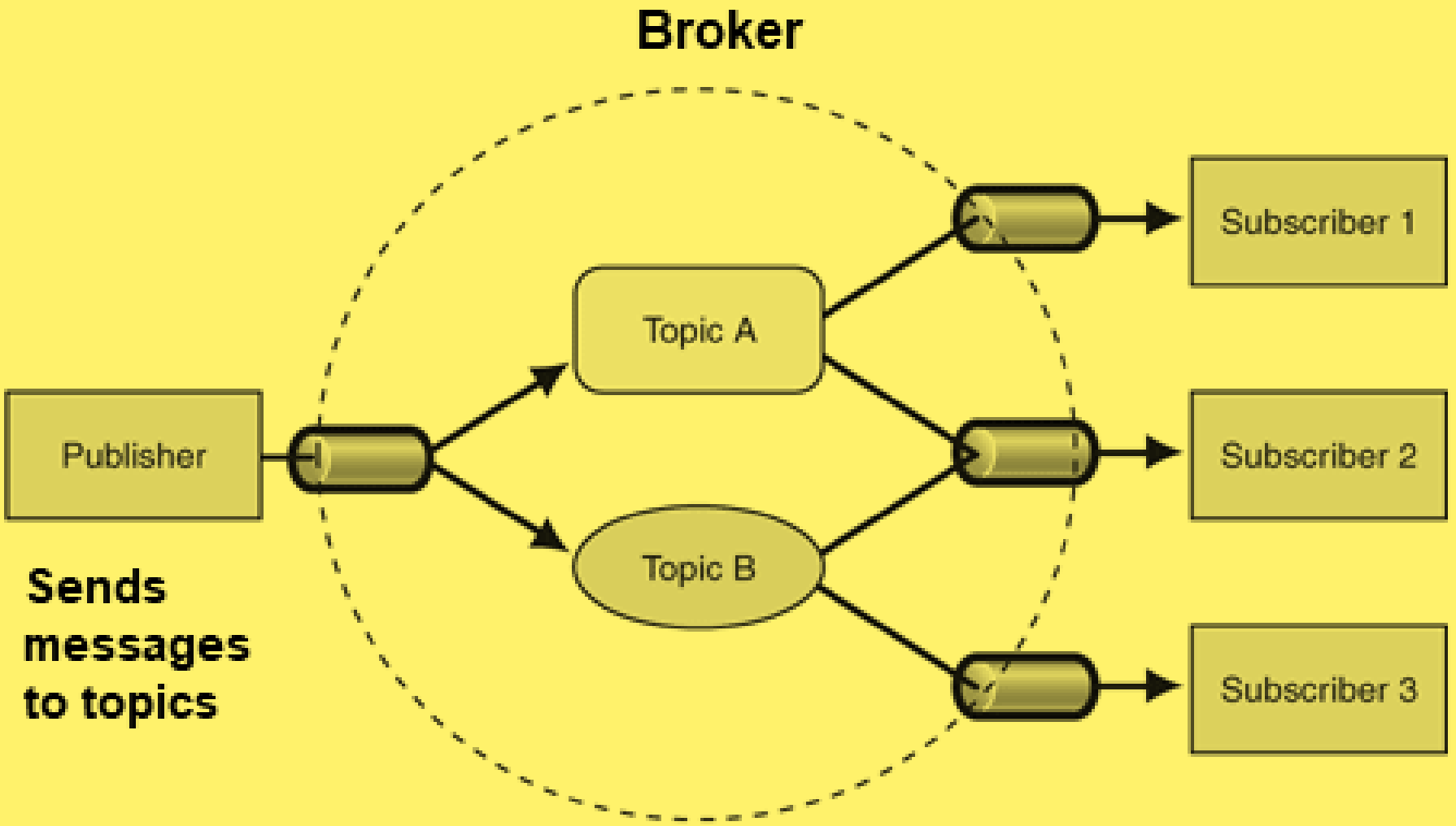


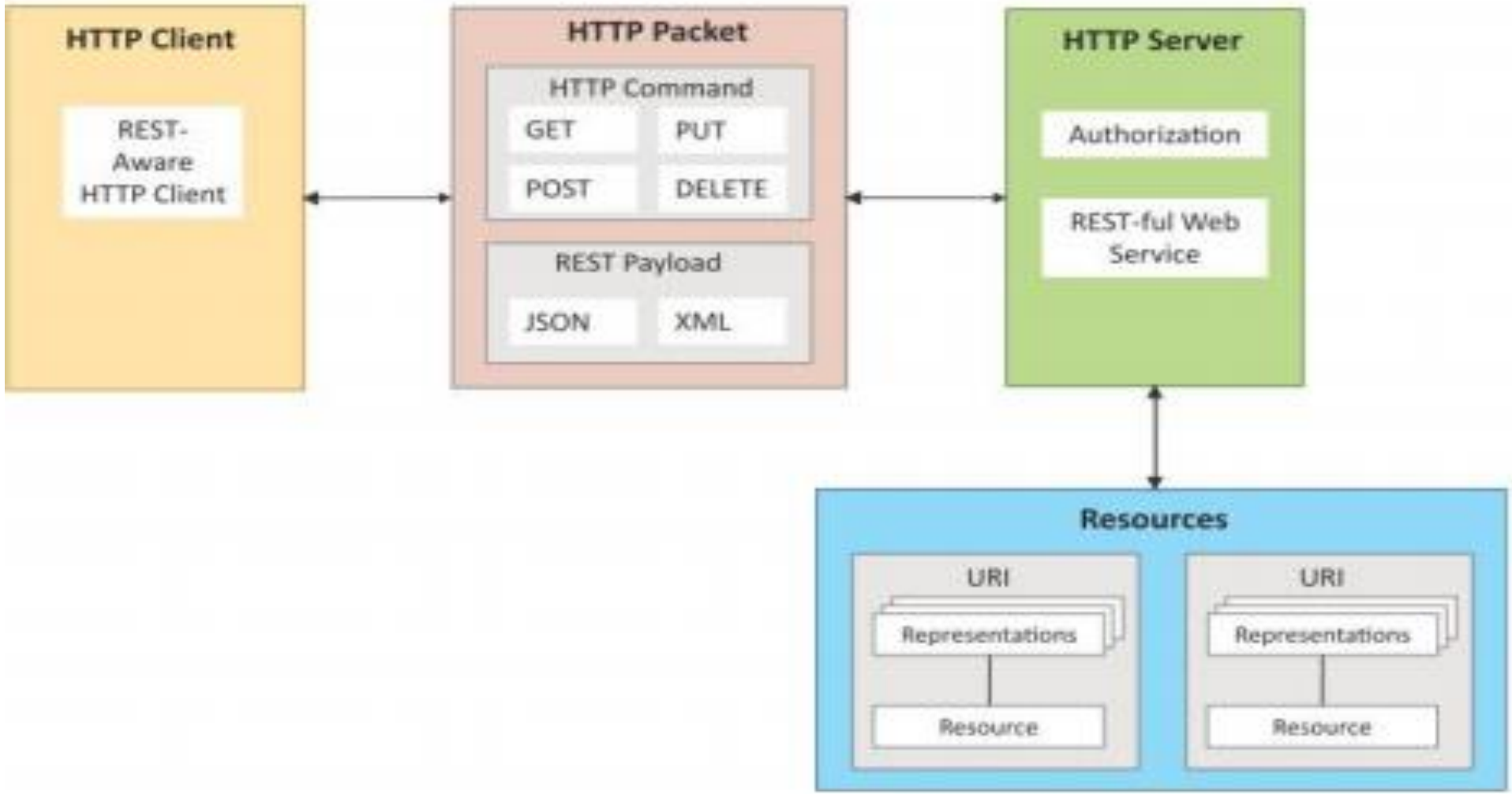
Source: https://iotbyhvm.ooo/iot-communication-models/

Publish-Subscribe communication model

- Publish-Subscribe is a communication model that involves publishers, brokers and consumers.
- Publishers :
  - Publishers are the source of data.
  - Publishers send the data to the topics which are managed by the broker.
  - Publishers are not aware of the consumers.
- Consumers subscribe to the topics which are managed by the broker.
- When the **broker receives data** for a topic from the publisher, it **sends the data to all the subscribed consumers**

REST-based Communication APIs

- **Representational State Transfer (REST)** is a set of architectural principles by which you **can design web services and web APIs.**
- **It** focus on a system's resources and how **resource states are addressed and transferred.**
- REST APIs follow the **request- response communication model**.
- The REST architectural constraints apply to the **components, connectors, and data elements, within a distributed hypermedia system**


HTTP Client
REST-
Aware
HTTP Client
HTTP Packet
HTTP Command
GET
PUT
POST
DELETE
REST Payload
JSON
XML
HTTP Server
Authorization
REST-ful Web
Service
Resources
URI
Representations
Resource
URI
Representations
Resource

REST-based Communication APIs

Client-server

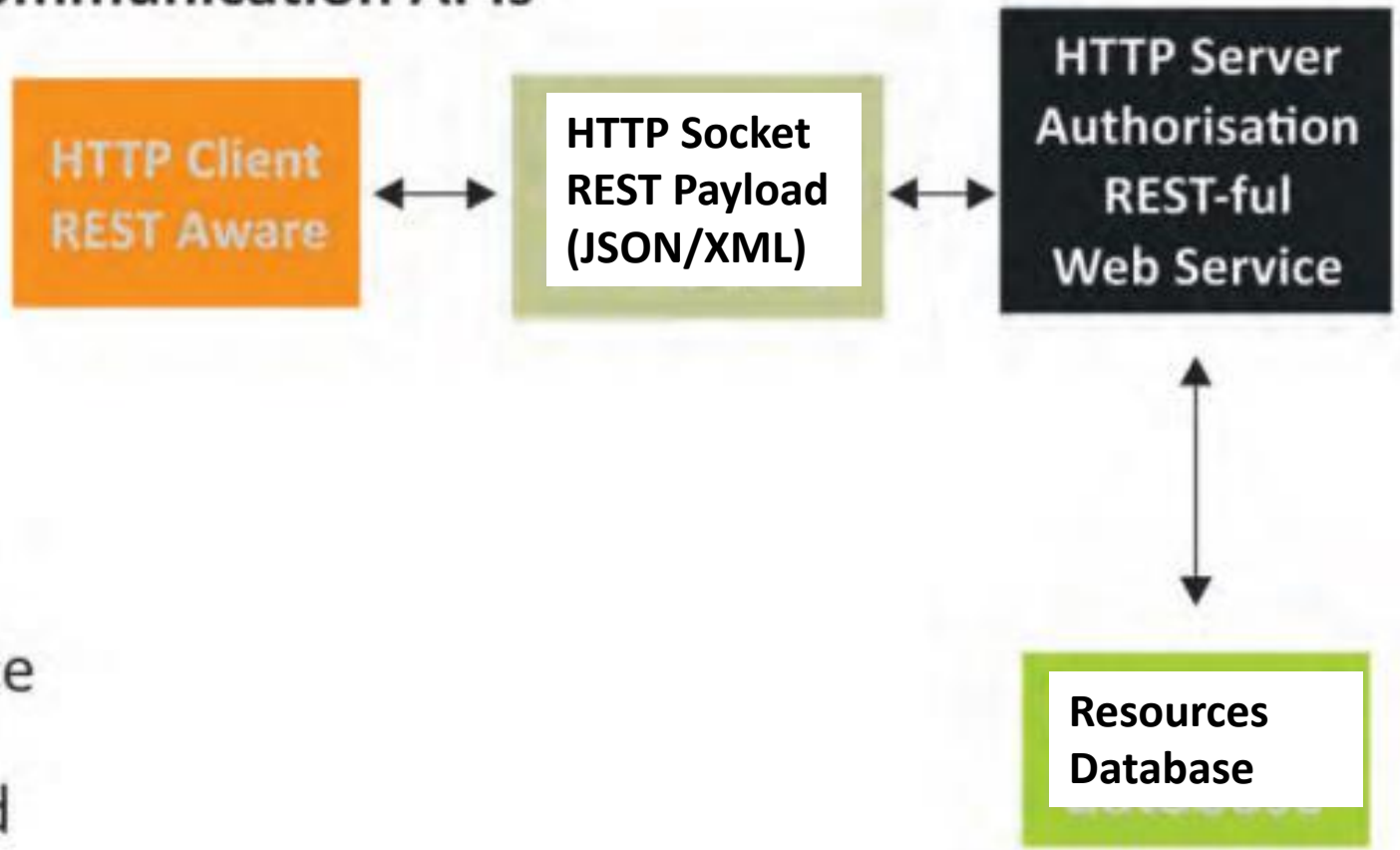
Stateless

Cache-able

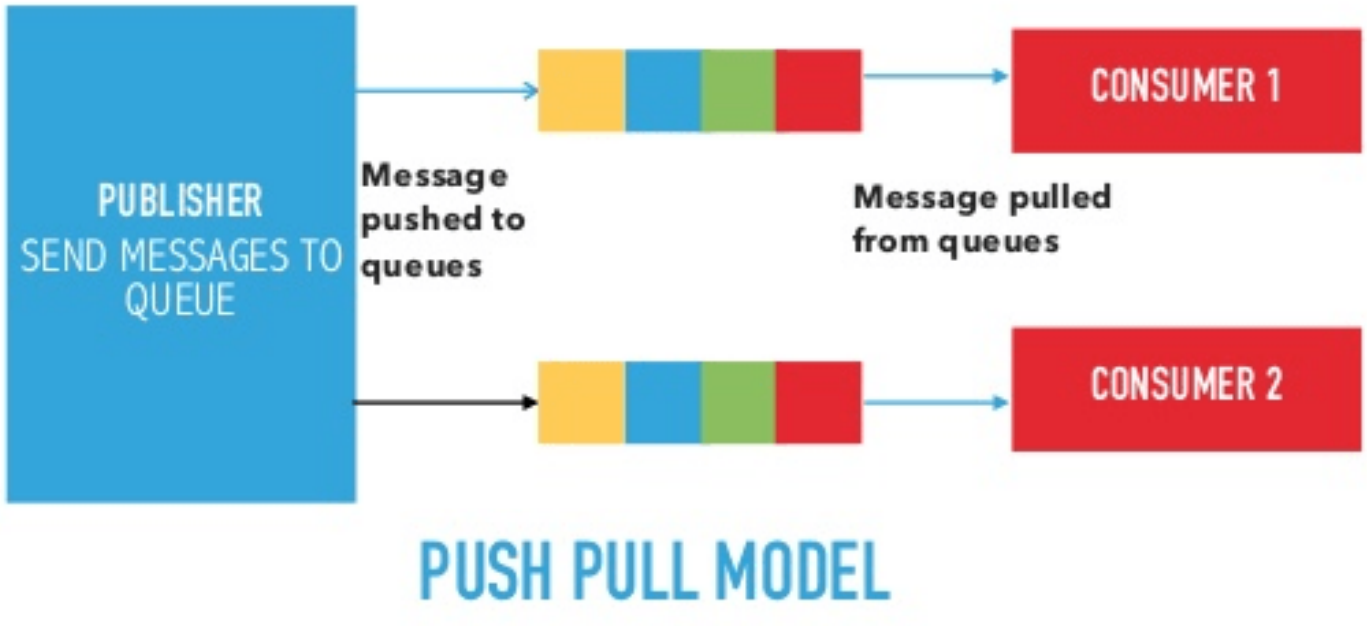
Layered system

Uniform interface

Code on demand



Push-Pull communication model

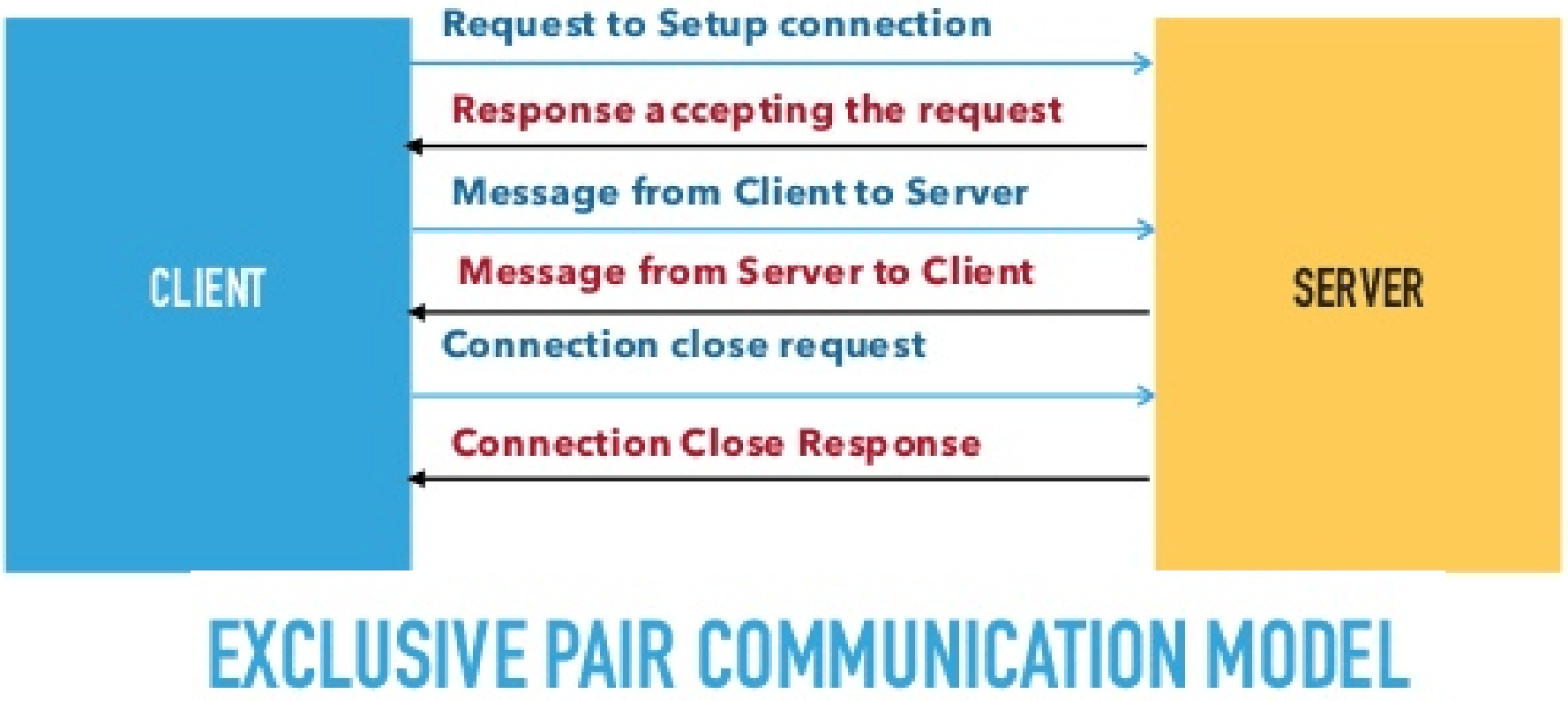


Courtesy: https://iotbyhvm.ooo/iot-communication-models/

Push-Pull communication model

- Push-Pull is a communication model in which the data producers push the data to queues and the consumers pull the data from the queues.
- Producers do not need to be aware of the consumers.
- Queues help in decoupling the messaging between the producers and consumers.
- Queues also act as a buffer which helps in situations when there is a mismatch between the rate at which the producers push data and the rate at which the consumers pull data.

Exclusive Pair communication model

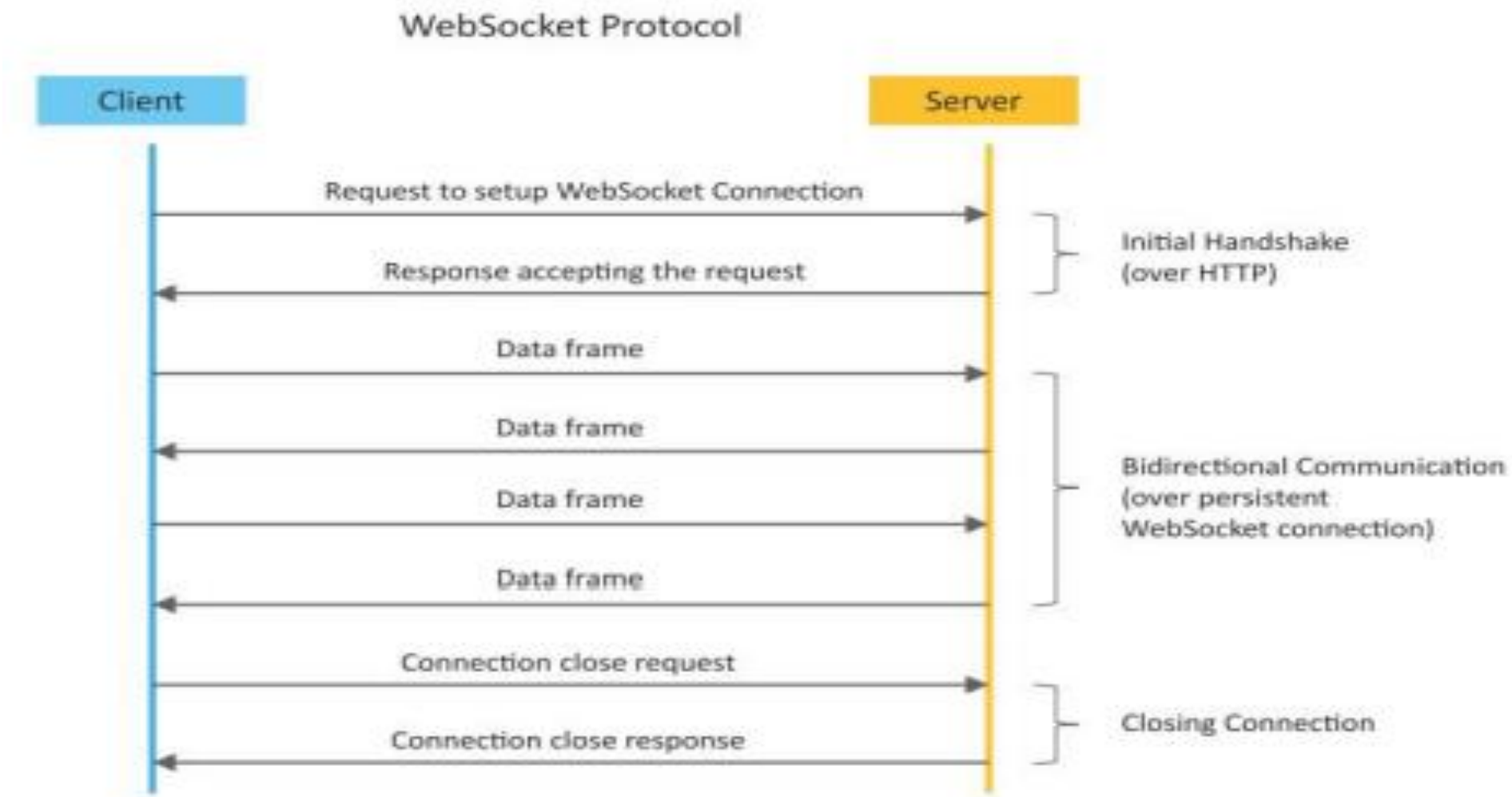


Courtesy: https://iotbyhvm.ooo/iot-communication-models/

Exclusive Pair communication model

- Exclusive Pair is a **bidirectional**, fully duplex communication model that uses a persistent connection between the client and server.
- Once the **connection is setup** it remains open until the client sends a request to close the connection.
- Client and server can send messages to each other **after** connection setup.

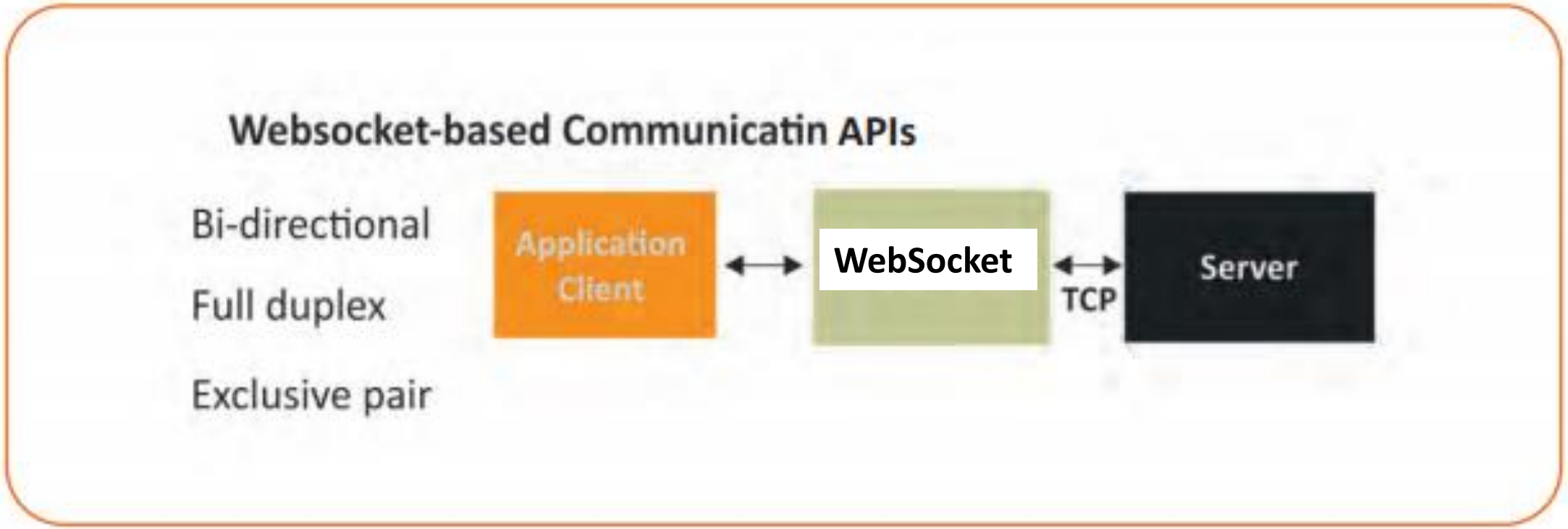
WebSocket-based Communication APIs



WebSocket-based Communication APIs

- WebSocket APIs allow **bi- directional, full duplex** communication between clients and servers.
- WebSocket APIs follow the **exclusive pair communication model**

WebSocket


Websocket-based Communicatin APIs
Bi-directional
Full duplex
Exclusive pair
Application Client
WebSocket
TCP
Server

IoT System

- Device
- Resource
- Controller Service
- Database
- Web service
- Analysis Component
- Application

Device :

An IoT device allows identification, remote sensing, remote monitoring capabilities.

Resource:

• Software components on the IoT device for

-accessing, processing and storing sensor information,

-controlling actuators connected to the device.

- enabling network access for the device.

Controller Service:

• Controller service is a native service that runs on the device and interacts with the web services.

• It sends data from the device to the web service and receives commands from the application (via web services) for controlling the device.

Database:

• Database can be either local or in the cloud and stores the data generated by the IoT device.

Web Service:

• Web services serve as a link between the IoT device, application, database and analysis components.

•It can be implemented using HTTP and **REST** principles (REST service) or using the **WebSocket** protocol (WebSocket service).

Analysis Component:

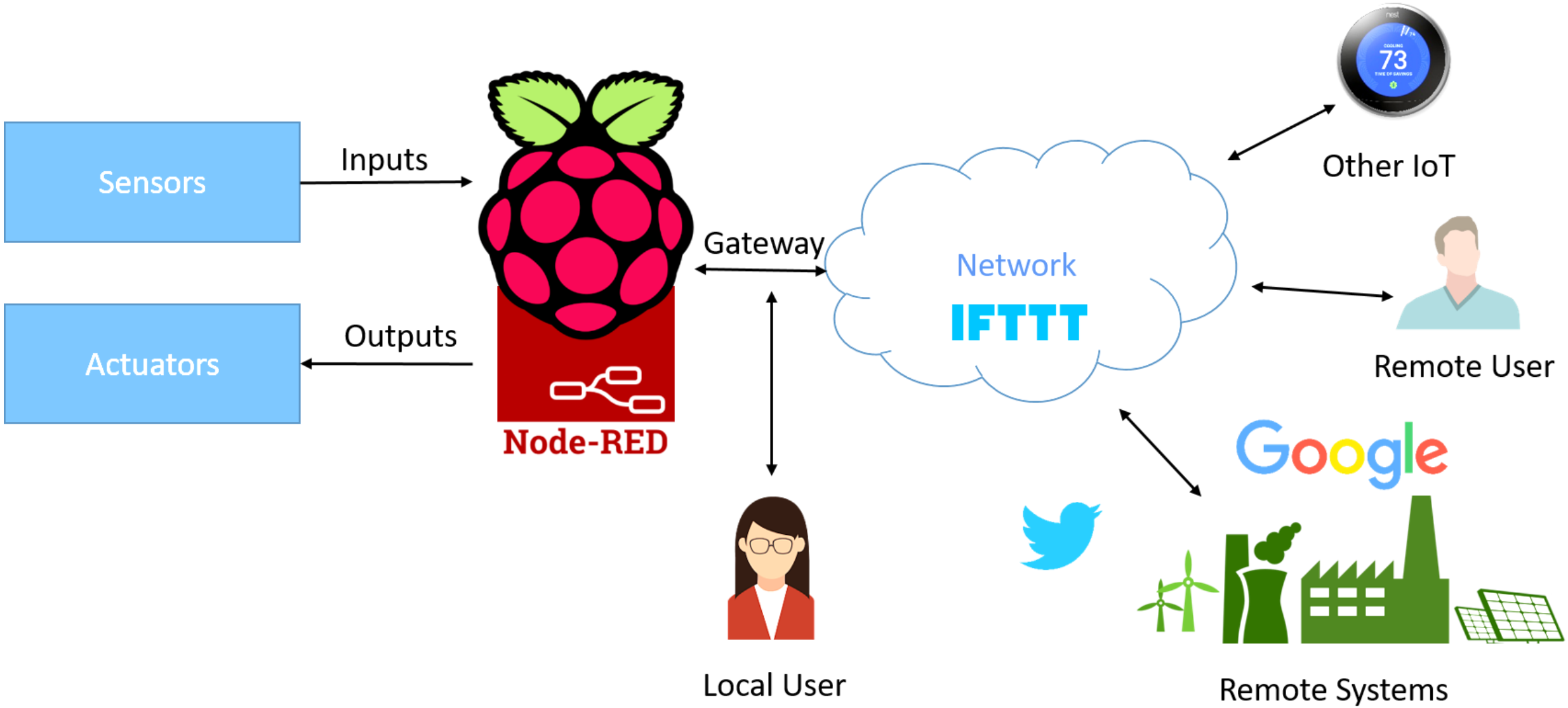
• Analysis Component is responsible for analyzing the IoT data and generating results in a form that is easy for the user to understand.

Application:

• IoT applications provide an interface that the users can use to control and monitor various aspects of the IoT system.

• Applications also allow users to view the system status and the processed data.

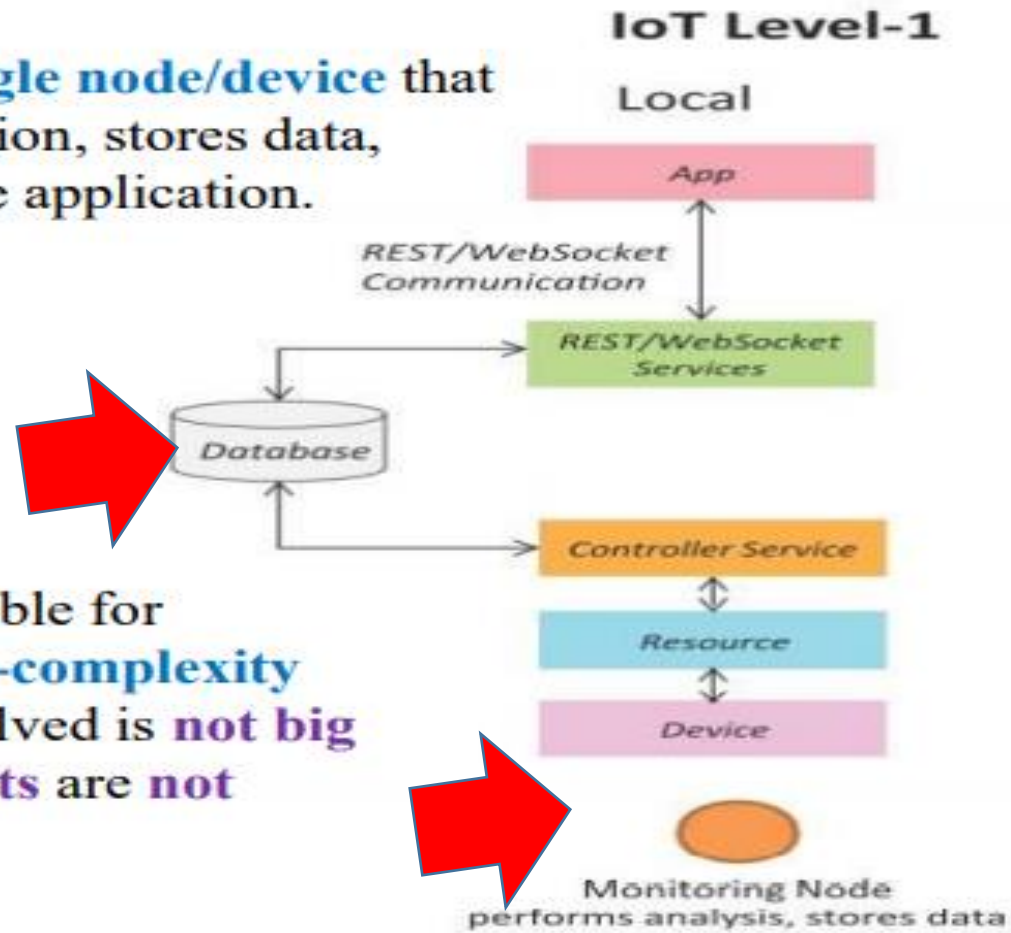
IoT system


Sensors
Inputs
Actuators
Outputs
Node-RED
Gateway
Network
IFTTT
Other IoT
Remote User
Local User
Google
Remote Systems

IOT Levels

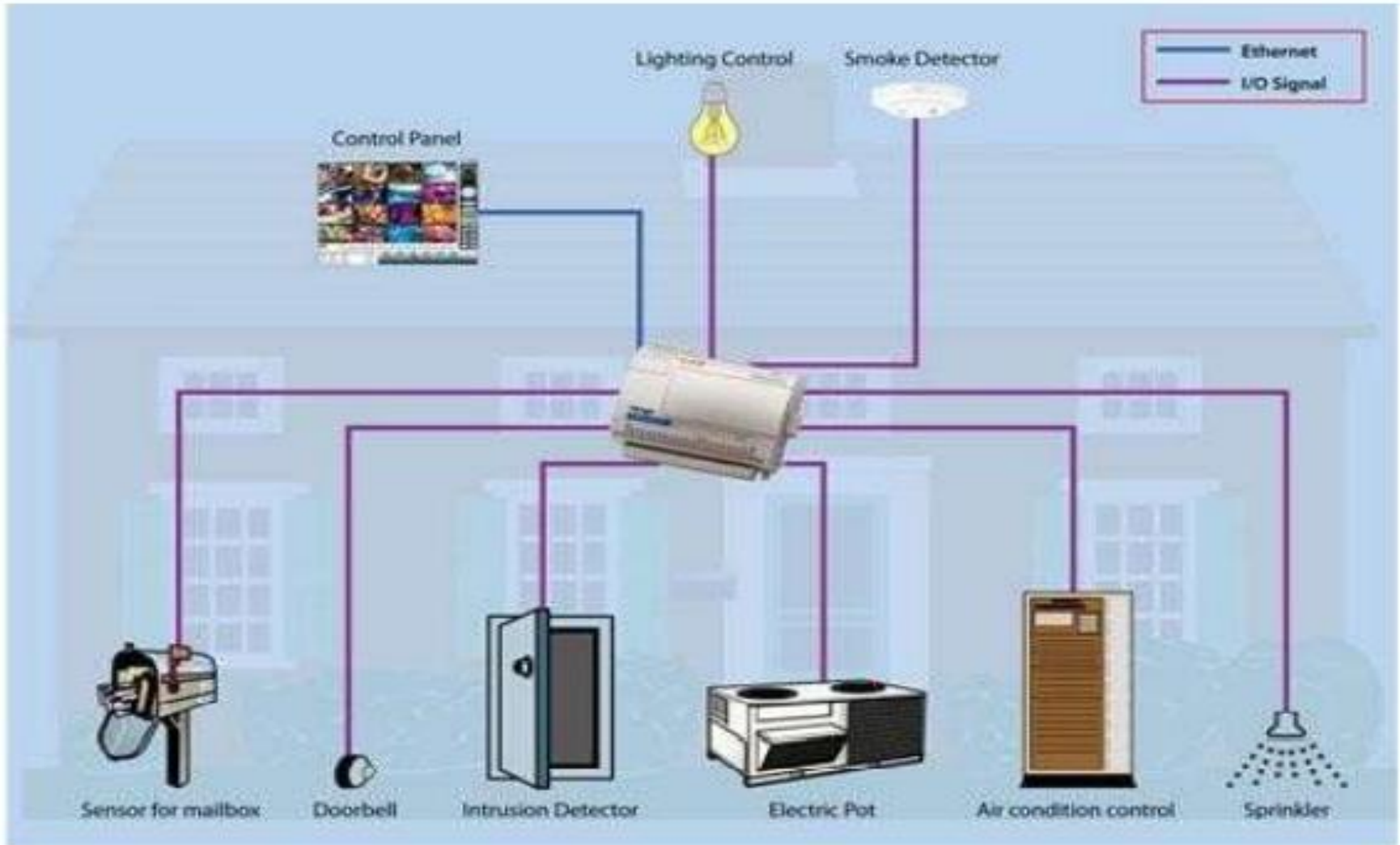
IoT Level-1

A level-1 IoT system has a **single node/device** that performs sensing and/or actuation, stores data, performs analysis and hosts the application.



Level-1 IoT systems are suitable for modelling **low- cost and low-complexity** solutions where the data involved is **not big** and the **analysis requirements** are **not computationally intensive.**

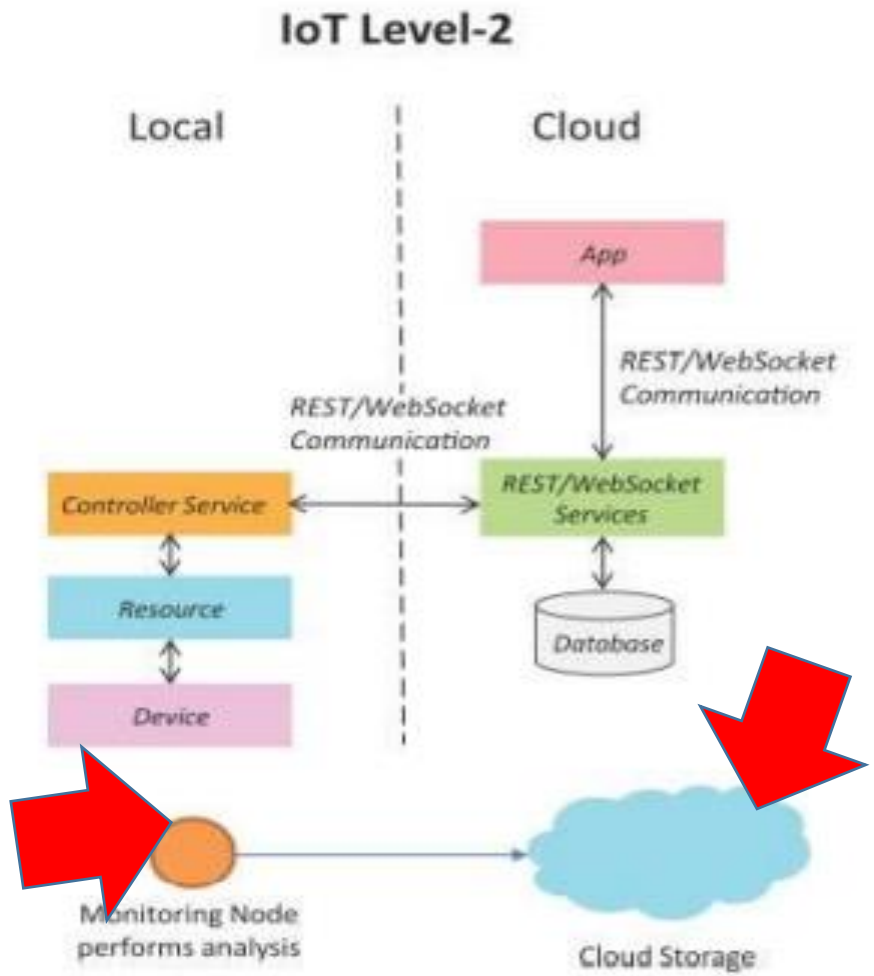
IoT – Level 1 Example : Home Automation System



IoT Level-2

- A level-2 IoT system has a **single node** that performs sensing and/or actuation and **local analysis**.
Data is stored in the cloud and the **application is usually cloud-based**.

- Level-2 IoT systems are suitable for solutions where the **data involved is big**; however, the **primary analysis** requirement is **not computationally intensive** and can be done locally.

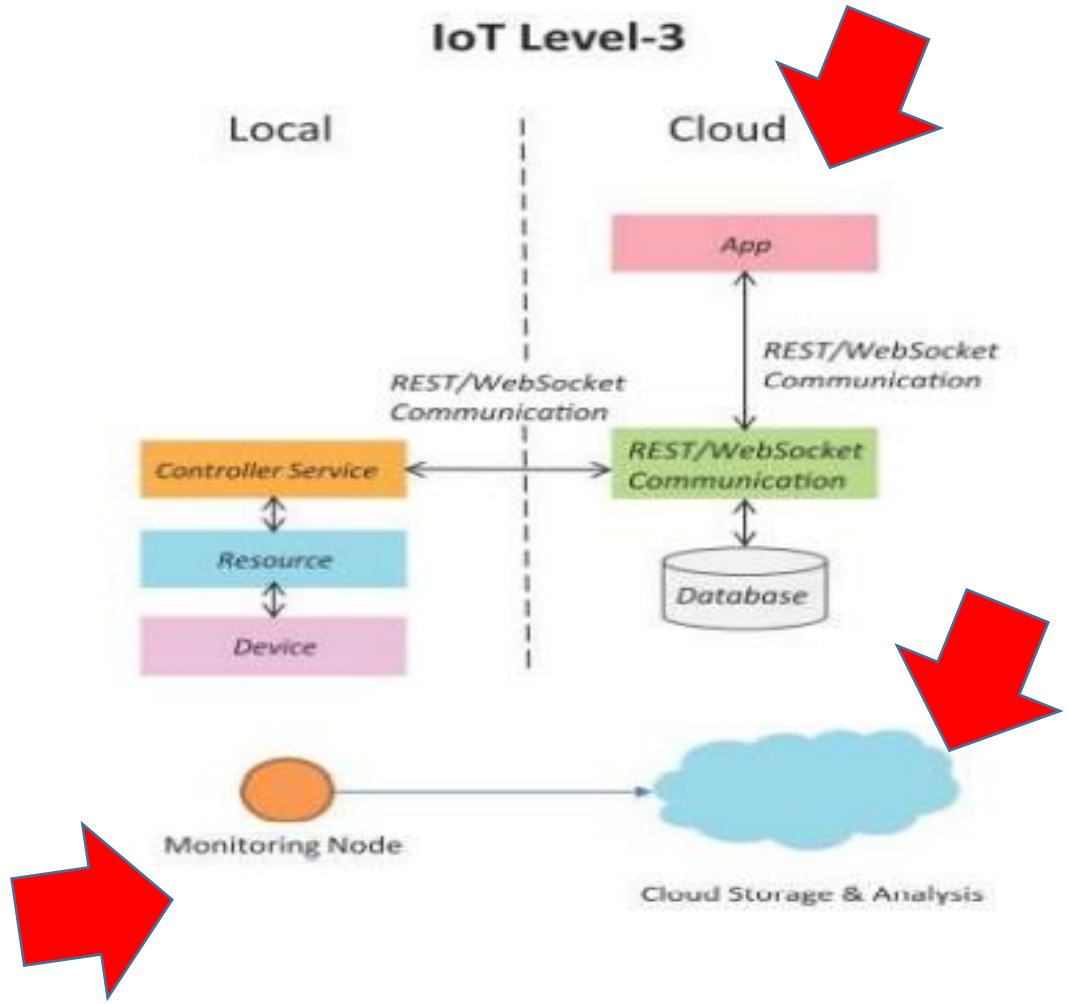


IoT – Level 2 Example: Smart Irrigation

IoT Level-3

A level-3 IoT system has a **single node**. Data is stored and **analyzed in the cloud** and the **application is cloud-based.**

Level-3 IoT systems are suitable for solutions where the **data involved is big** and the **analysis requirements are computationally intensive**.

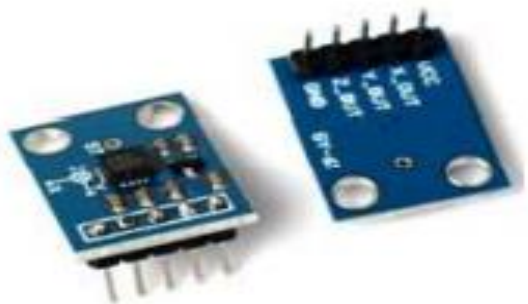


IoT – Level 3 Example: Tracking Package Handling

Sensors used

Accelrometer

sense movement or vibrations



Gyroscope

Gives orientation info

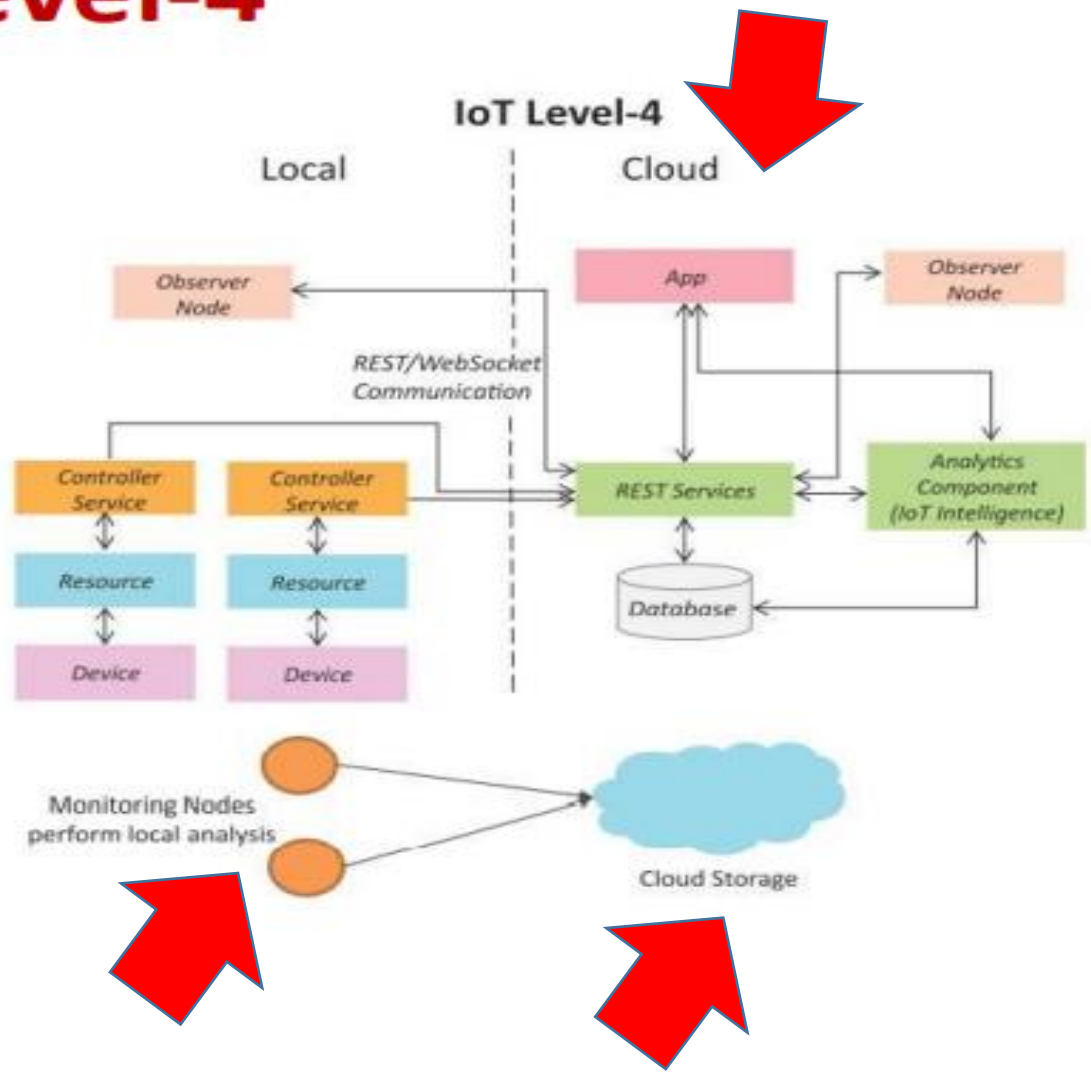
Websocket service is used because sensor data can be sent in real time.

IoT Level-4

A level-4 IoT system has **multiple nodes** that perform **local analysis**. **Data is stored in the cloud** and the application is cloud-based.

Level-4 contains local and cloud-based **observer nodes** which can subscribe and receive information collected in the cloud from IoT devices.

Level-4 IoT systems are suitable for solutions where **multiple nodes are required**, the **data involved is big** and the **analysis requirements are computationally intensive.**

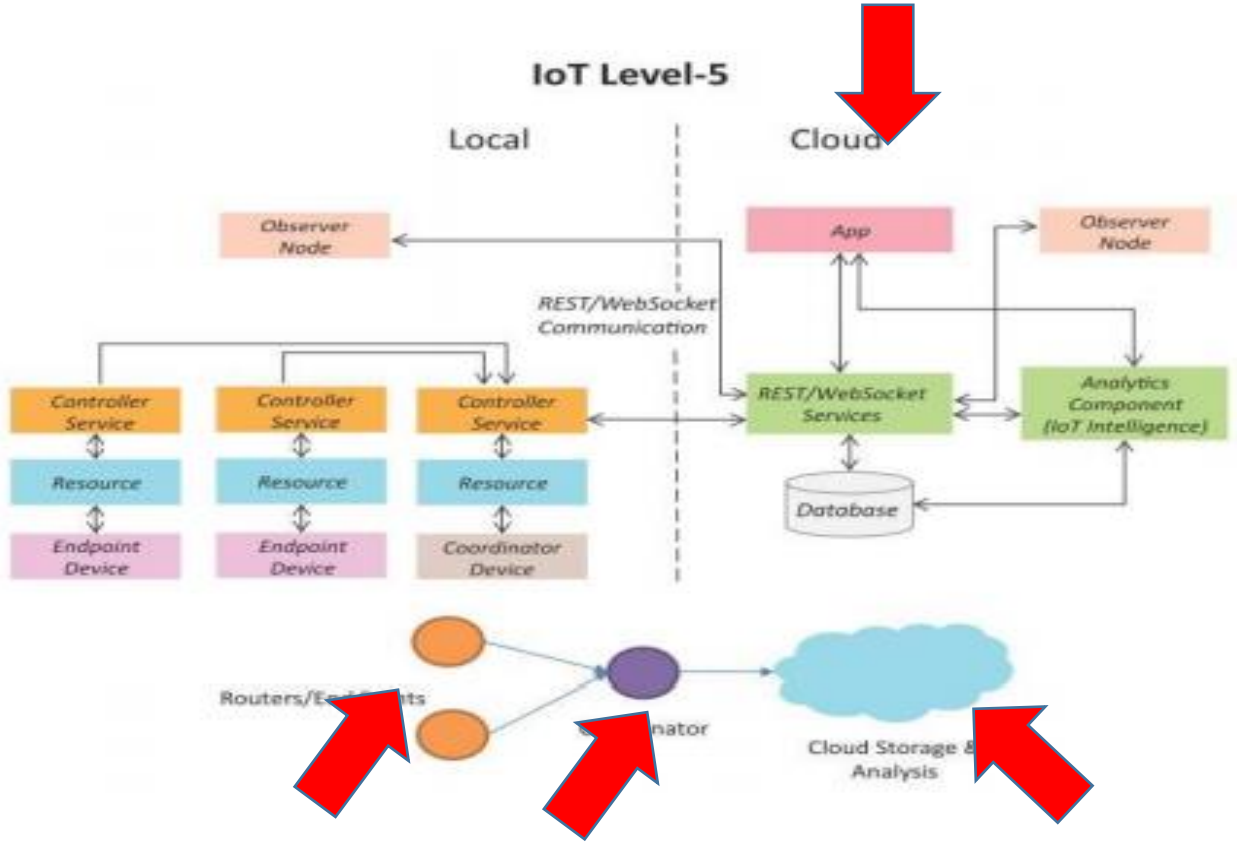


IoT – Level 4 Example: Noise Monitoring

Sound Sensors are used

IoT Level-5

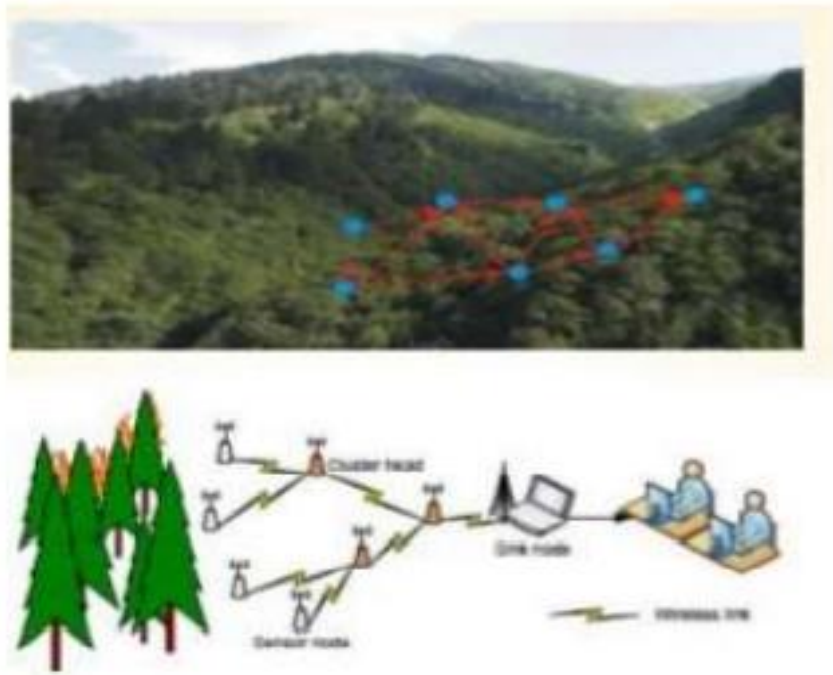
- A level-5 IoT system has **multiple end nodes** and **one coordinator node.**
- The end nodes perform sensing and/or actuation.
- The coordinator node **collects data from the end nodes and sends it to the cloud.**
- Data is stored and **analyzed in the cloud** and the **application is cloud- based.**



Level-5 IoT systems are suitable for **solutions based on wireless sensor networks**, in which the **data involved is big** and the **analysis requirements are computationally intensive.**

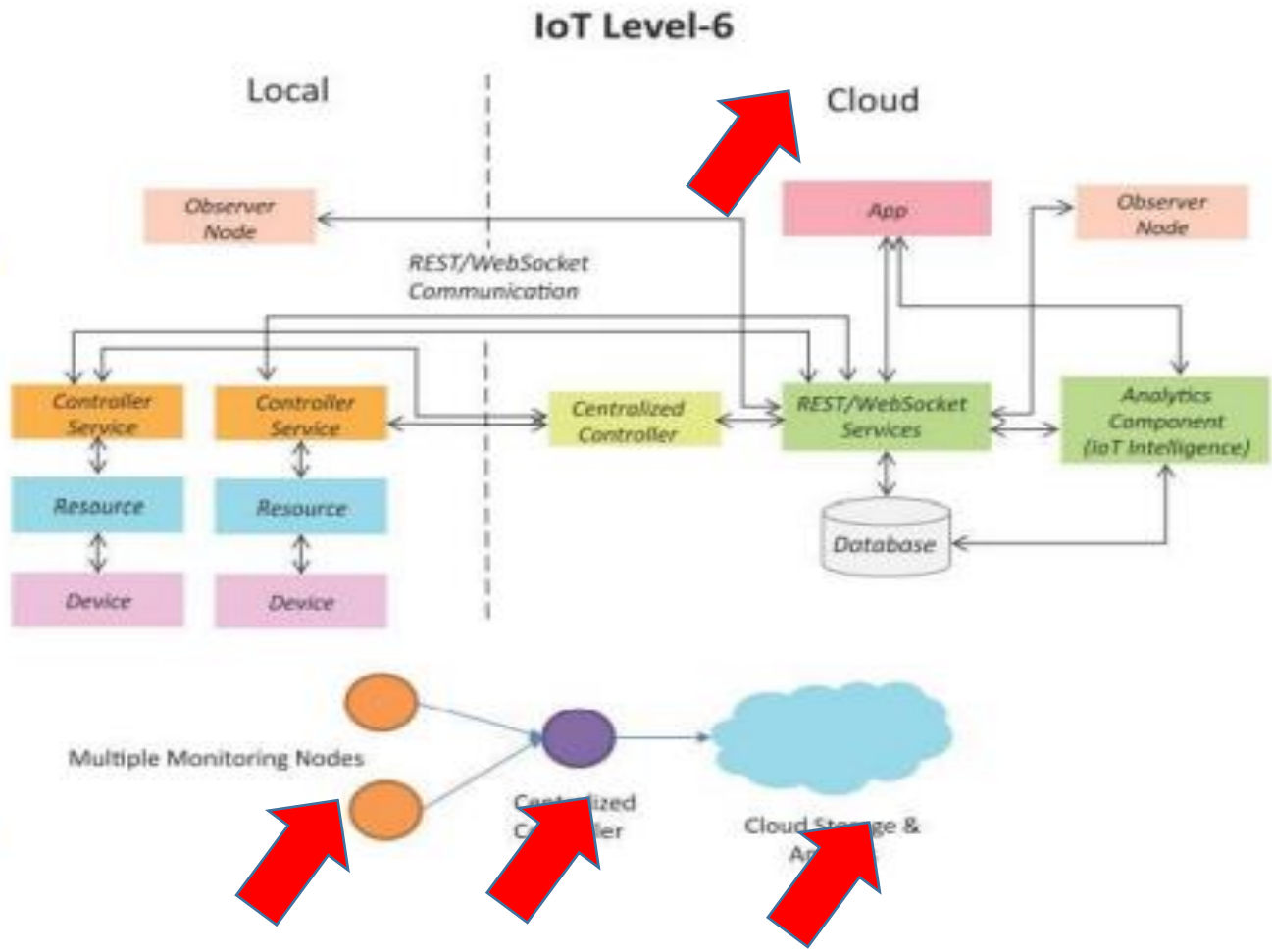
IoT – Level 5 Example: Forest Fire Detection

Detect forest fire in early stages to take action while the fire is still controllable.
Sensors measure the temperature, smoke, weather, slope of the earth, wind speed, speed of fire spread, flame length



IoT Level-6

- A level-6 IoT system has **multiple independent end nodes** that perform sensing and/or actuation and send data to the cloud.
- **Data is stored in the cloud** and the **application is cloud-based**.
- The **analytics** component analyzes the data and stores the results in the **cloud database**.
- The results are visualized with the cloud-based application.
- The **centralized controller** is aware of the status of all the end nodes and **sends control commands to the nodes**.



IoT – Level 6 Example: Weather Monitoring System

Sensors used

- Wind speed and direction
- Solar radiation
- Temperature (air, water, soil)
- Relative humidity
- Precipitation
- Snow depth
- Barometric pressure
- Soil moisture

IoT – Level 6 Example: Weather Monitoring System

Sensors used

Wind speed and direction
Solar radiation
Temperature (air, water, soil)
Relative humidity

Precipitation
Snow depth
Barometric pressure
Soil moisture

References

- Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A hands-on Approach”, University Press, 2015.
- Book website: http://www.internet-of-things-book.com

IOT @ businesses and society, IoT use cases and applications across industries

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Applications of IoT

Consumer
- Smart home control (lighting, security, comfort)
- Optimized energy use
- Maintenance

Retail
- Product tracking
- Inventory control
- Focused marketing

Medical
- Wearable devices
- Implanted devices
- Telehealth services

Military
- Resource allocation
- Threat analysis
- Troop monitoring

Industrial
- SmartMeters
- Wear-out sensing
- Manufacturing control
- Climate control

Automotive
- Parking
- Traffic flow
- Anti-theft location

Environmental
- Species tracking
- Weather prediction
- Resource management

Agriculture
- Crop management
- Soil analysis

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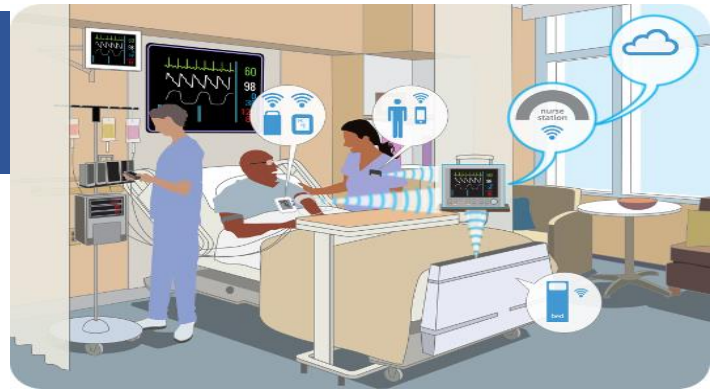
Few Applications of IoT

- ✓Building and Home automation
- ✓Manufacturing
- ✓Oil and Gas Sector
- ✓Medical and Healthcare systems
- ✓Media
- ✓Environmental monitoring
- ✓Infrastructure management
- ✓Energy management
- ✓Transportation
- ✓Better quality of life for elderly

Healthcare



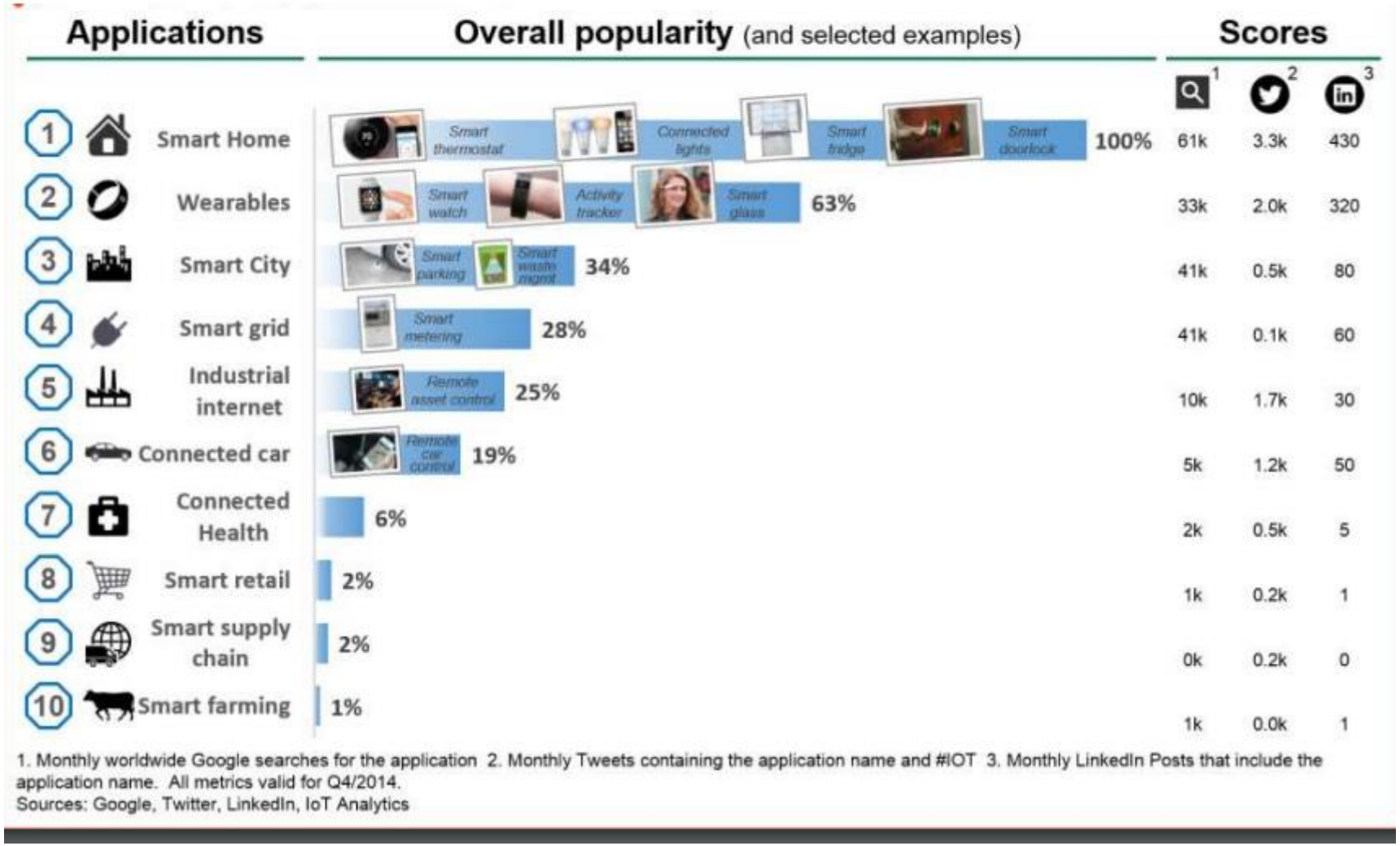
Smart Appliances

Wearable Tech

You name it, and you will have it in IoT!

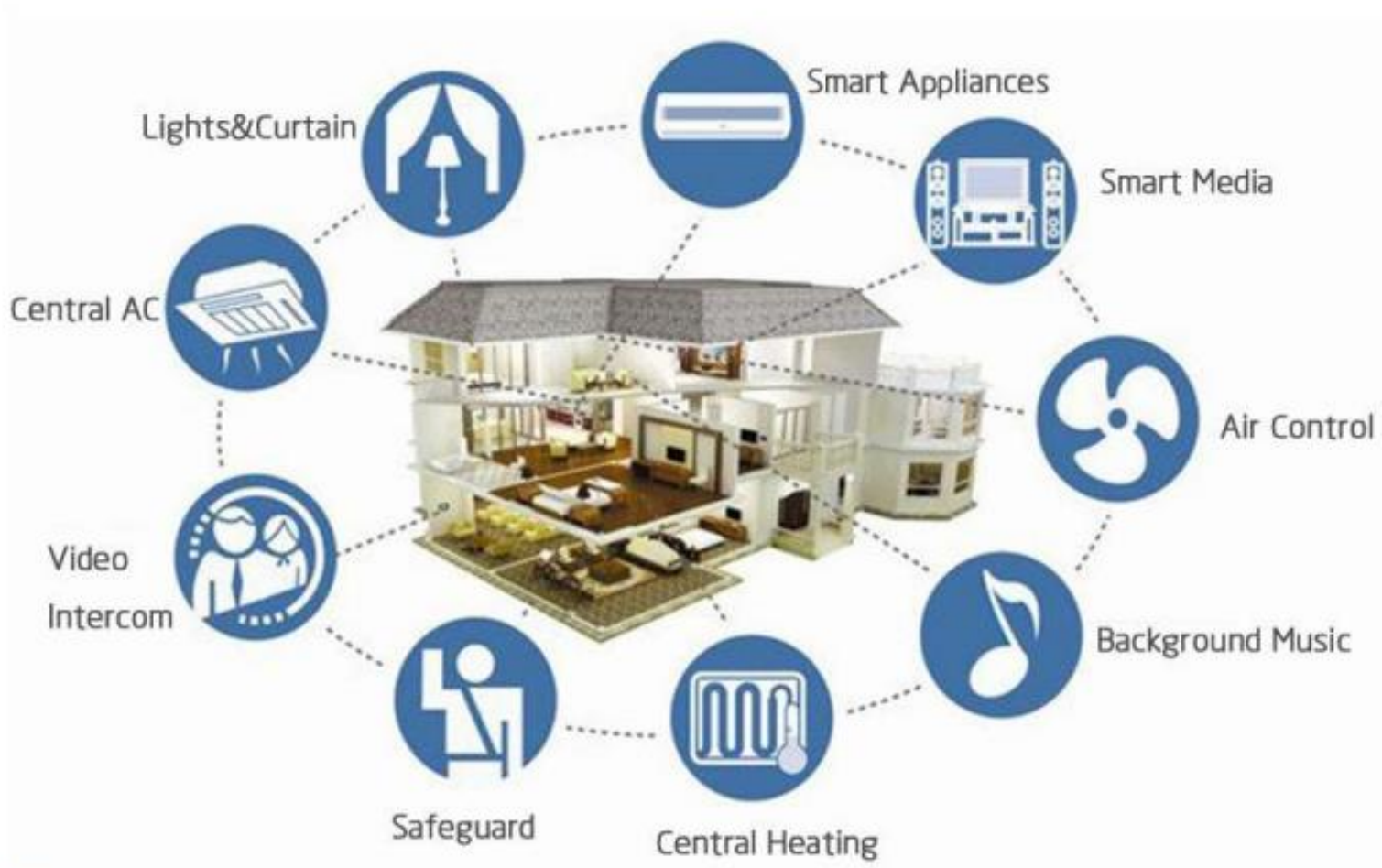
TO ➡ DIVERSE APPLICATIONS

The IoT Applications Ranking



IoT Case Study

SMART HOMES


Lights&Curtain
Smart Appliances
Smart Media
Central AC
Air Control
Video
Intercom
Background Music
Safeguard
Central Heating

Wearables

- The second hot area in IoT.
- Most of them connected with Smart phones.
- Devices worn on wrist

  Ex.Smart Watches-SAMSUNG GEAR
- Devices put on like a spectacle

  Ex. Google Glass
- Smart garments.
- Skin coloured Tatoo/patch like sensors.

WEARABLES

Wearable panic buttons

Can be built into jewelry or clothing, allowing you to quickly alert a pre-designated circle of trusted contacts, as well as the police, when in distress.

Safe driving internables

Ingestible pills with sensors, which measure blood alcohol content. This could then communicate with your car, rendering it useless if you exceed the legal limit.

Smart garments

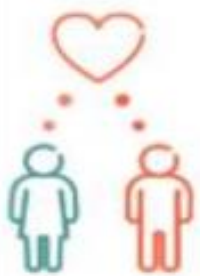
Slow wash garments

Garments with inbuilt sensors that alert you when the garment needs to be washed, helping you to save water and energy.

Exact measure garments

Equipped with built-in sensors that send your body's measurements to an app, which then recommends clothes online that match your requirements.

Non-verbal communication



Embrace

A smart garment that allows physical touch to be transferred wirelessly between couples and recreated on their skin.

Mood detector

Skin-colored patch or tattoo-like sensor that tracks your mood throughout the day and recommends actions to take.

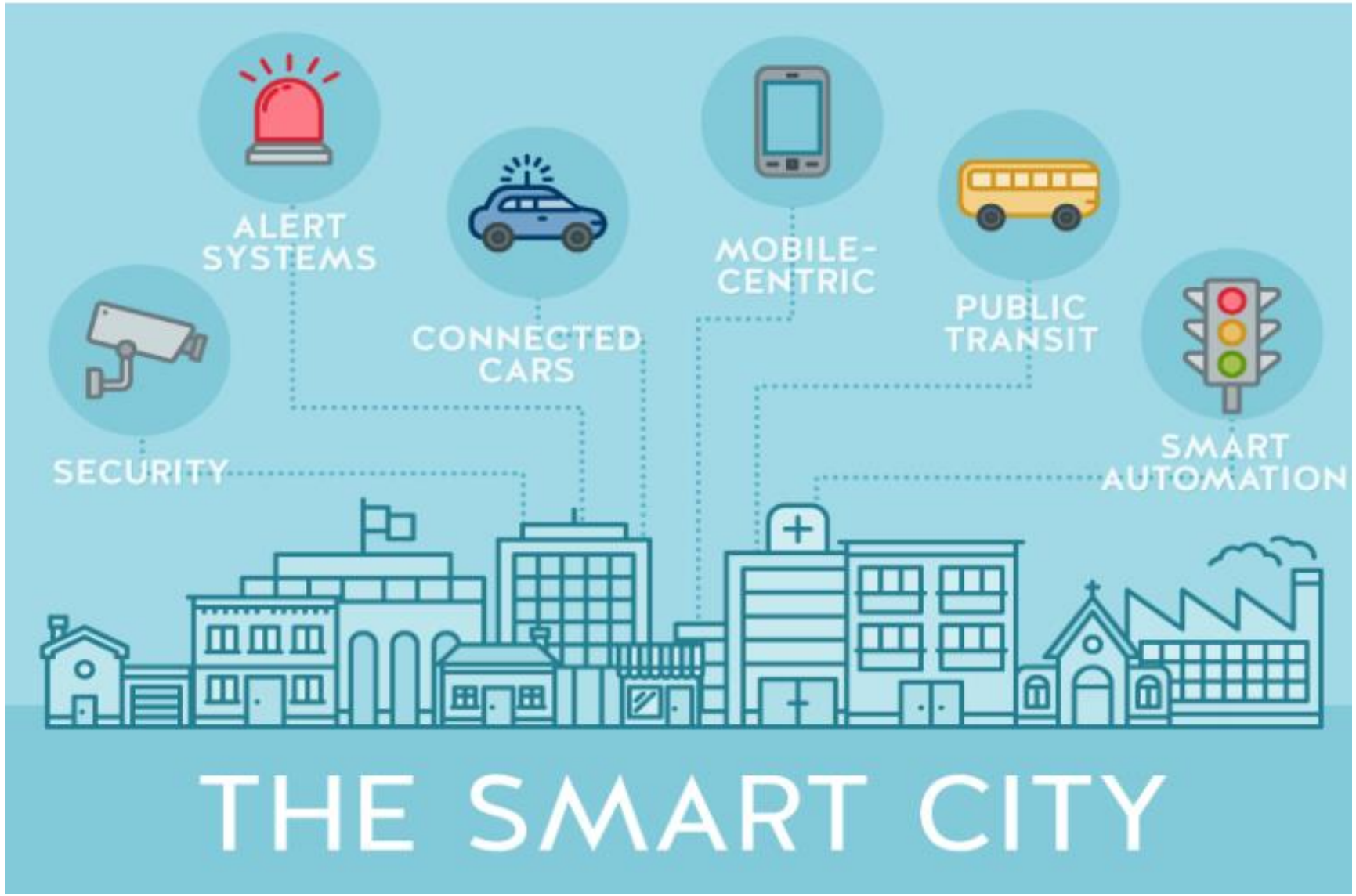
Smart Parking

Residents can identify and reserve the closest available space, traffic wardens can identify non-compliant usage, and municipalities can introduce demand-based pricing.

[Source: http://www.telecomreseller.com/2014/01/11/cisco-study-says-ioe-can-create-savings/]

Smart city

- Smart city includes **traffic management to water distribution, to waste management, urban security and environmental monitoring**.
- Many Smart City solutions have promised to alleviate real pains of people living in cities these days.
- IoT solutions in the area of Smart City solve **traffic congestion problems, reduce noise and pollution and help make cities safer.**


ALERT SYSTEMS
CONNECTED CARS
MOBILE-CENTRIC
PUBLIC TRANSIT
SECURITY
SMART AUTOMATION
THE SMART CITY

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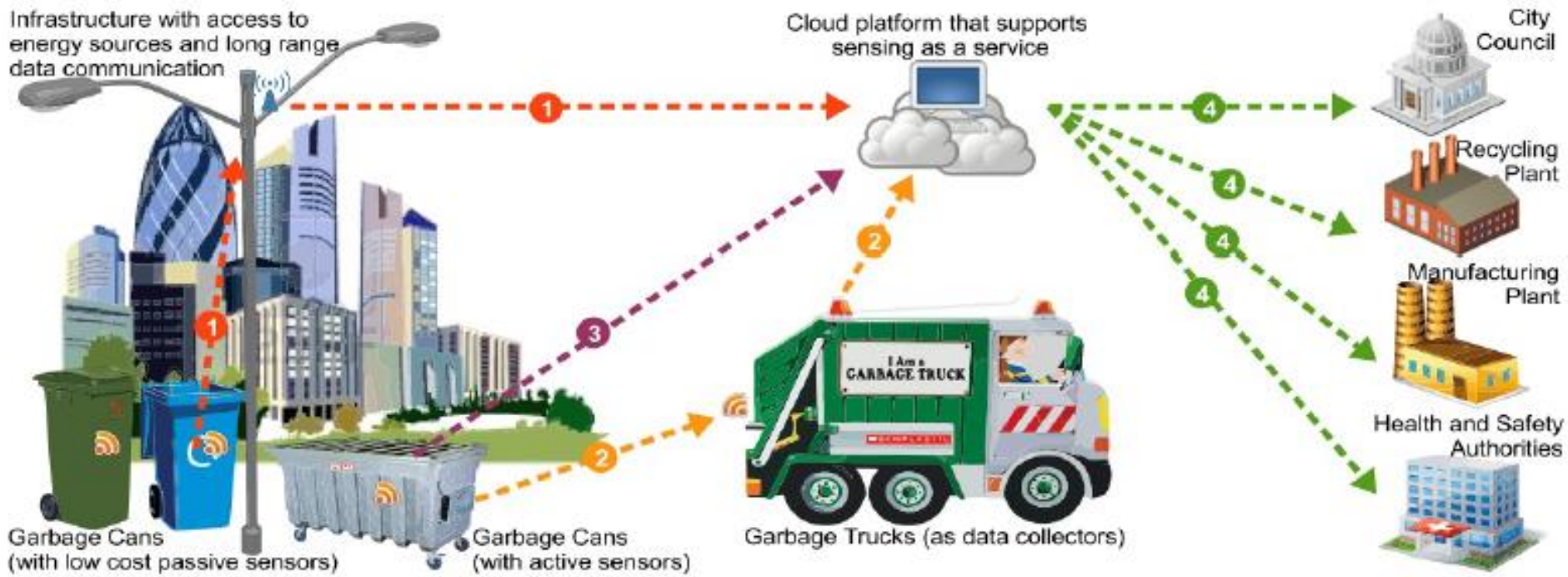
Efficient Waste Management in Smart Cities Supported by the Sensing-as-a-Service

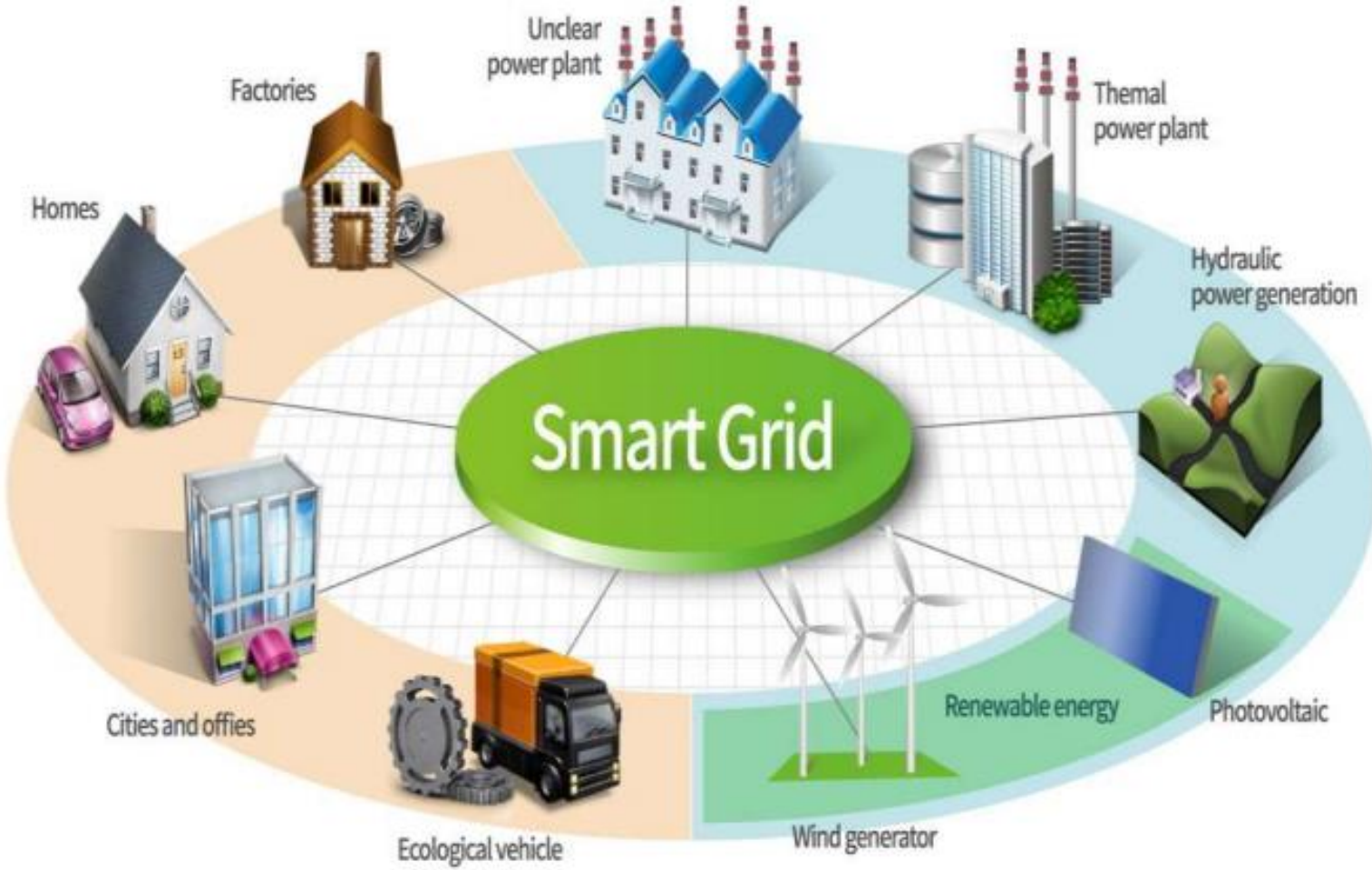


[Source: "Sensing as a Service Model for Smart Cities Supported by Internet of Things", Charith Perera et. al., Transactions on Emerging Telecommunications Technology, 2014]

Smart grid

- Smart grid uses information about the **behaviors of electricity suppliers and consumers in an automated fashion**.
- This technology helps in:
  1. Deliver power more efficiently
  2. Improve operations
  3. Reduce emissions and management costs
  4. Restore power failures faster.

SMART GRIDS

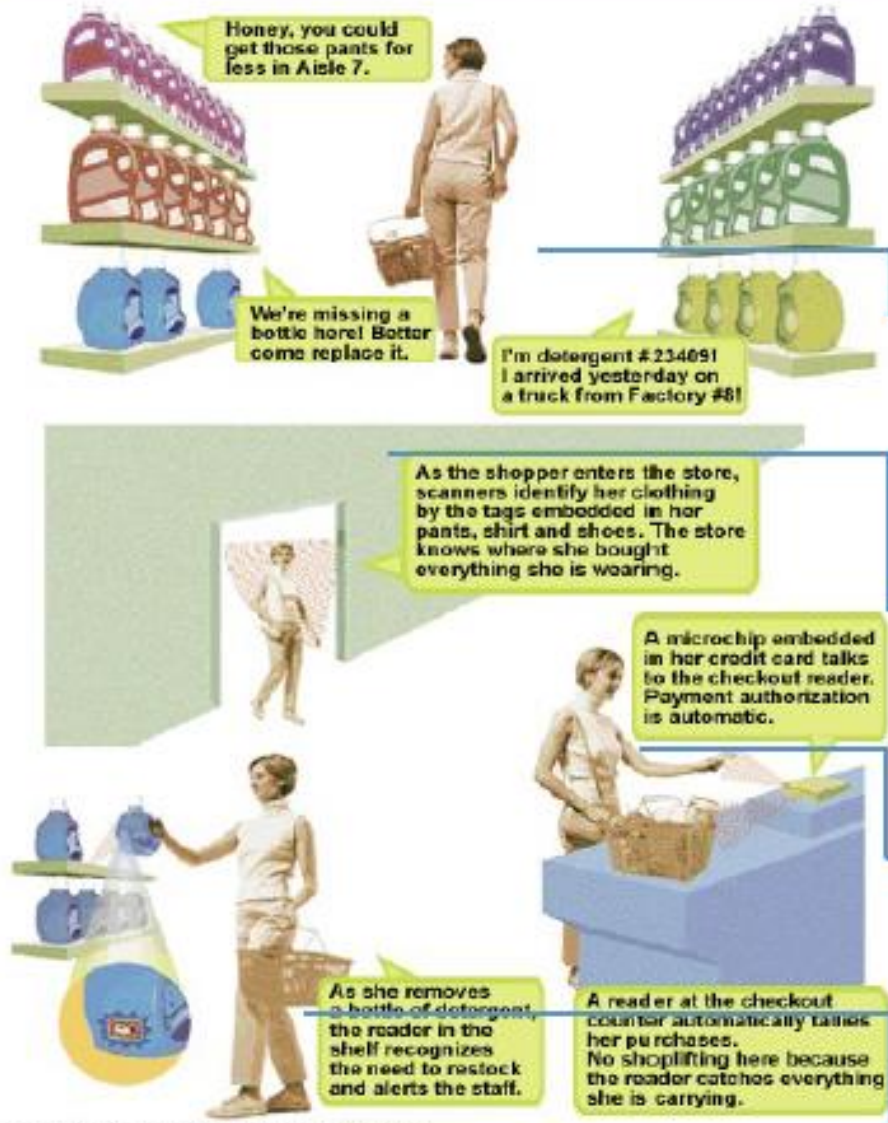

Unclear
power plant
Factories
Themal
power plant
Homes
Hydraulic
power generation
Smart Grid
Cities and offies
Renewable energy
Photovoltaic
Ecological vehicle
Wind generator

Smart Retail

- Focuses on 2 areas

1. Improving the customer experience
2. Optimizing supply chain operation

IOT Application Scenario - Shopping



(2) When shopping in the market, the goods will introduce themselves.

(1) When entering the doors, scanners will identify the tags on her clothing.

(4) When paying for the goods, the microchip of the credit card will communicate with checkout reader.

(3) When moving the goods, the reader will tell the staff to put a new one.


Create Fleet Efficiencies for Optimization
Life Cycle Visibility of Product
Understand Inventory Levels & Warehouse Stock
IoT Solutions for Supply Chain
Gain User Insight
Study Product Performance & Predict Failure

Connected Health

IoT in Healthcare is a heterogeneous computing, wirelessly communicating system of apps and devices that connects patients and health providers to diagnose, monitor, track and store vital statistics and medical information.

Few examples of IoT in Healthcare

- Headsets that measure brainwaves
- Clothes with sensing devices
- BP monitors
- Glucose monitors
- ECG monitors
- Pulse oximeters
- Sensors embedded in medical equipment, dispensing systems, surgical robots and device implants
- Any wearable technology device……..

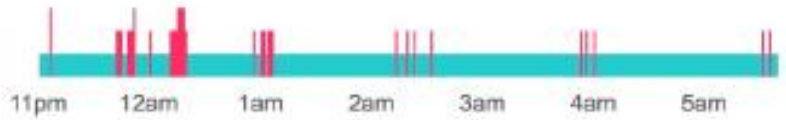
How Well Do I Sleep?

Sleep

zzzZ

YOUR SLEEP EFFICIENCY
92%

Your sleep pattern asleep awake



You went to bed at	Time to fall asleep	Times awakened	You were in bed for	Actual sleep time
11:00PM	0min	20	6hrs 40min	6hrs 6min

Sleep Stats

Time asleep over the past 30 days in hours

Times awoken over the past 30 days

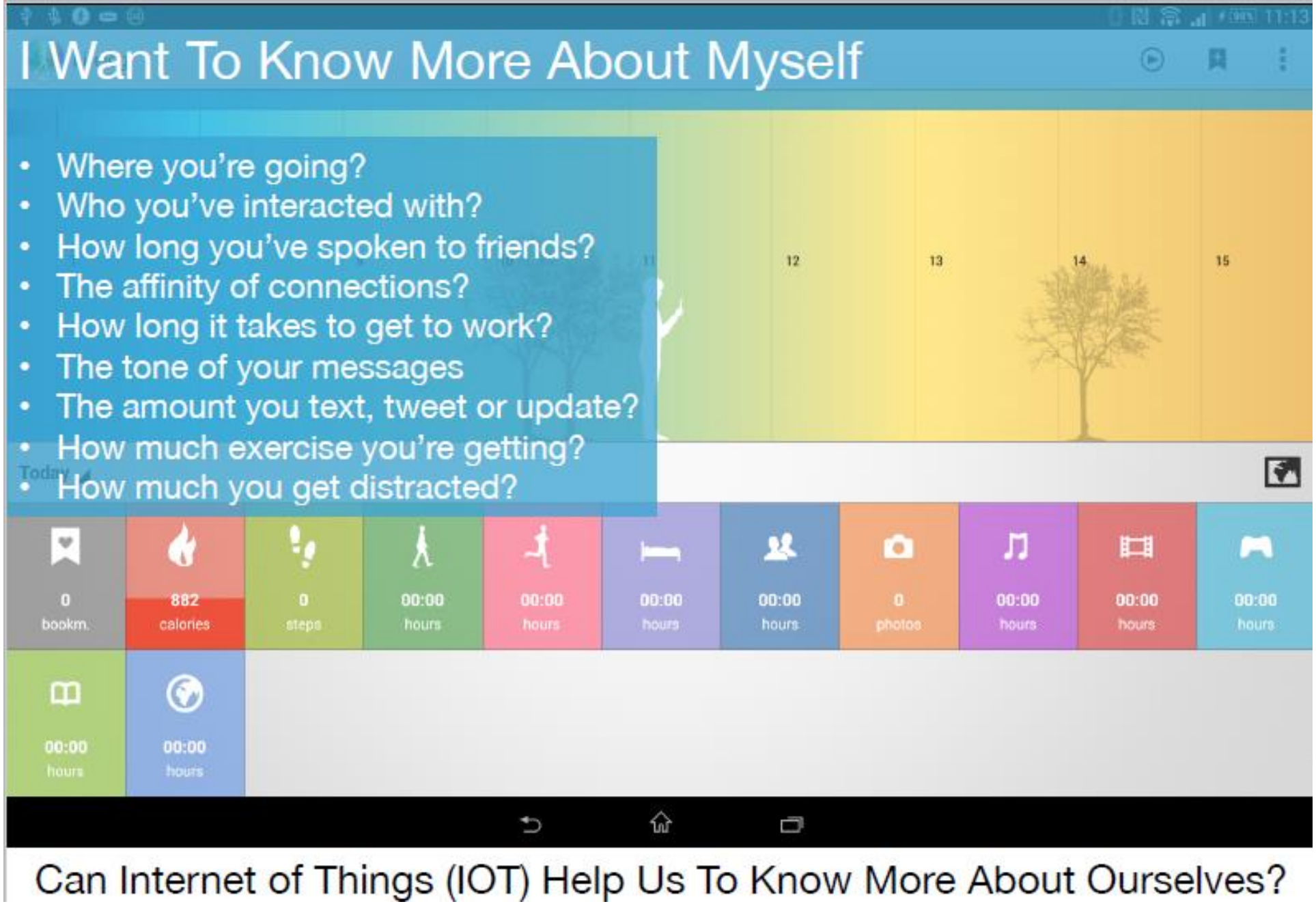
8 h 50 mins asleep

1d 1w 1m 3m 1y

- Awake for 212 mins (81x)
- Restless for 278 mins (91x)

Thursday, February 27

fitbit flex
Wireless Activity + Sleep Wristband



Can Internet of Things (IOT) Help Us To Know More About Ourselves?

IoT helps you in LIFE LOGGING

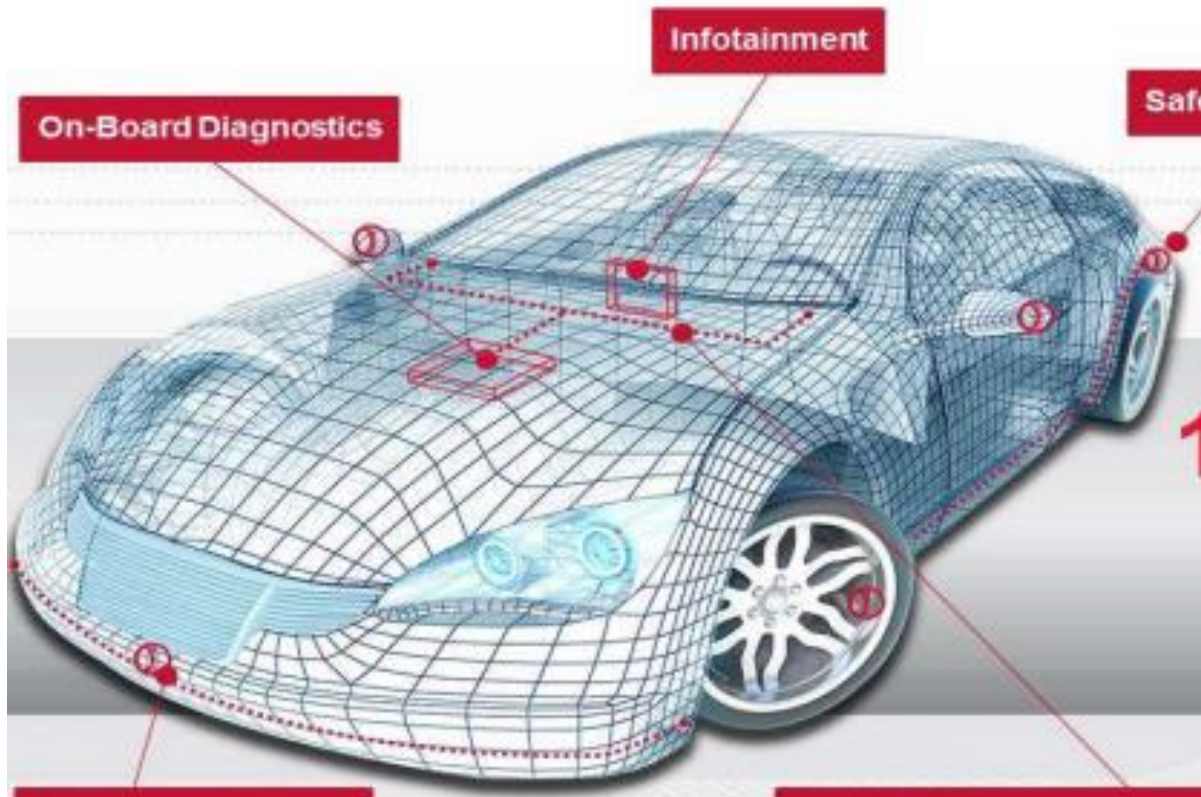

HOW MANY STEPS
HAVE YOU
WALKED TODAY?

Connected Car

- Applications can be separated into two categories:

1. In vehicle applications
2. V2V (Vehicle to vehicle) applications

THE CONNECTED CAR

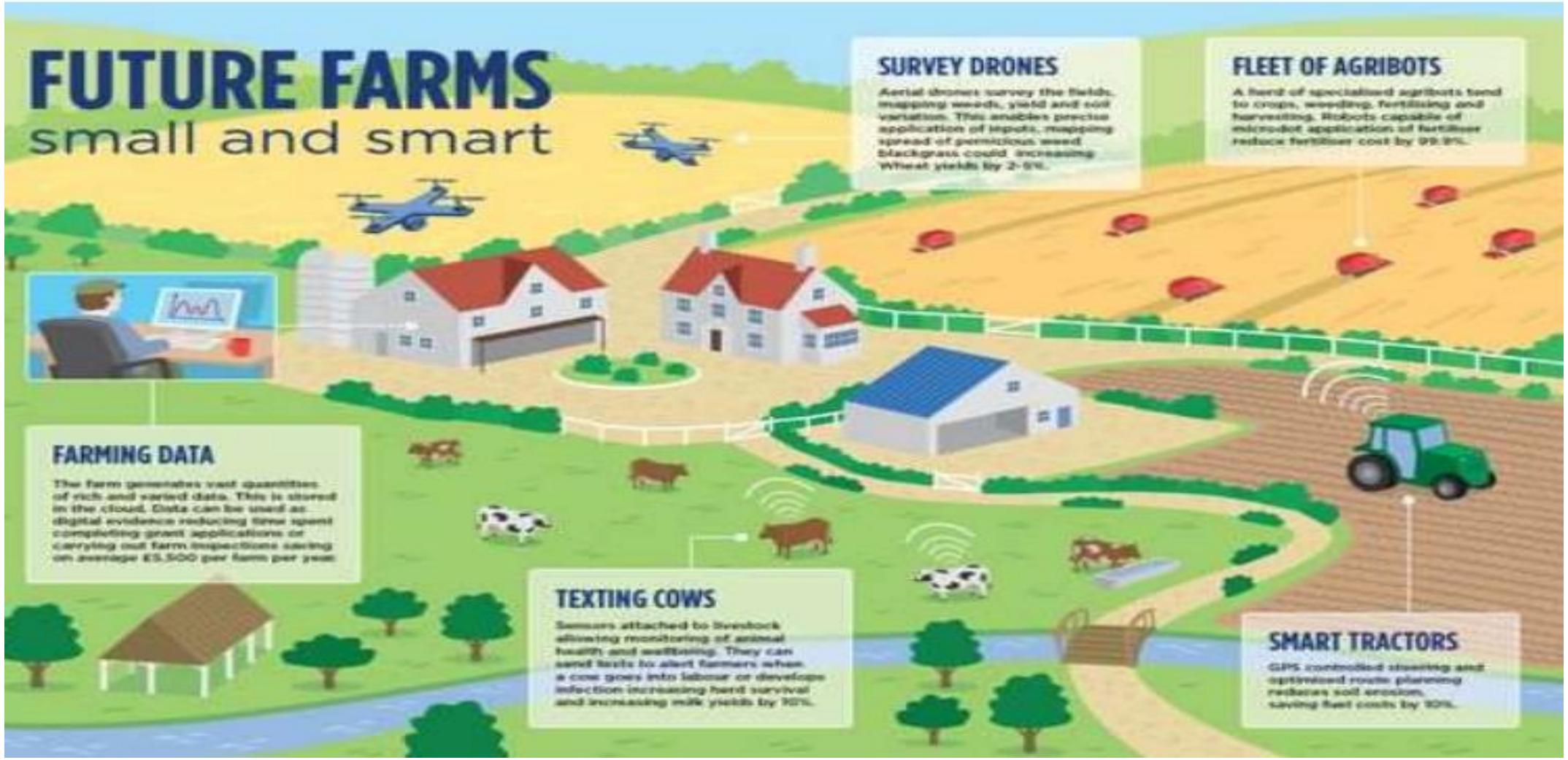


100% Of cars will be connected by 2025[1]

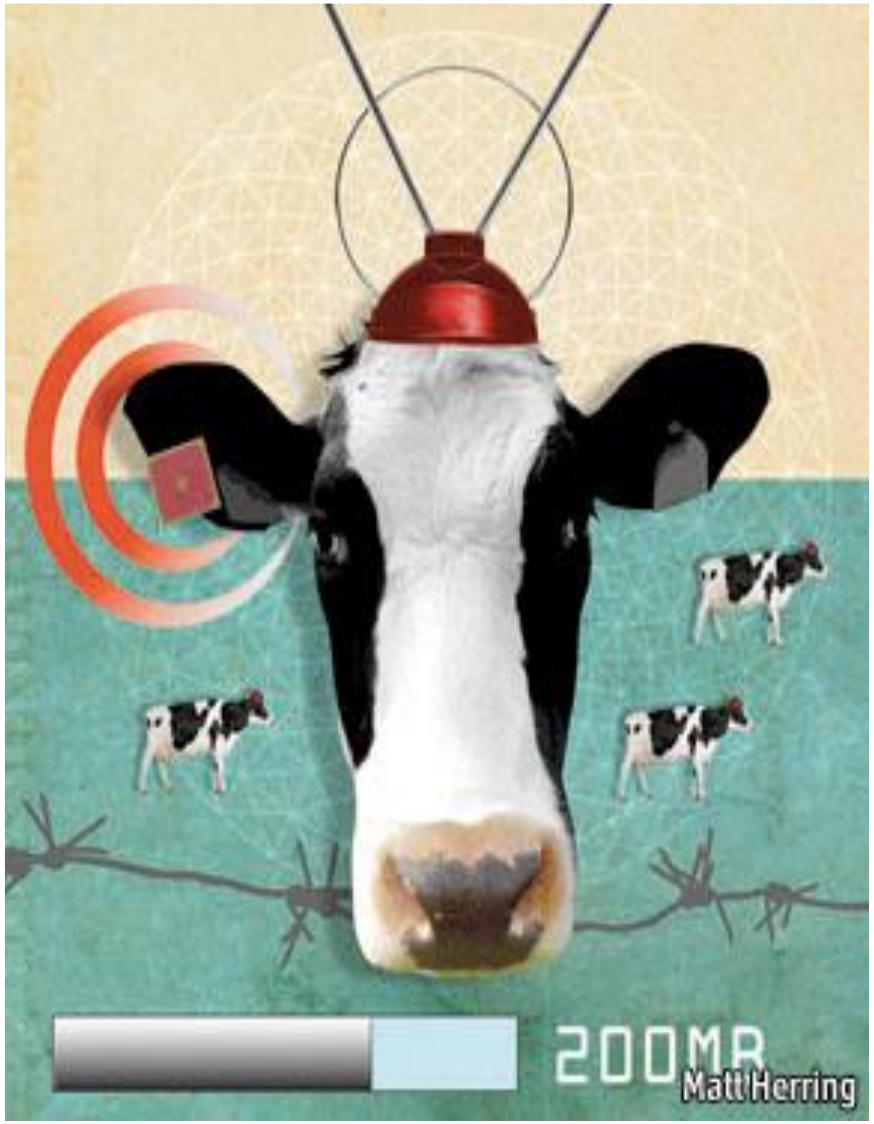
75% Of cars on the road will be autonomous by 2035[2]

Source: [1]GSMA 2013, [2]Navigant Research 2013

Smart Farming



Sensors in even the holy cow!



In the world of IoT, even the cows will be connected and monitored.

Sensors are implanted in the ears of cattle.

This allows farmers to monitor **cows' health and track their movements, ensuring a healthier, more plentiful supply of milk and meat for people to consume.**

On average, each cow generates about 200 MB of information per year.

Industrial Internet of Things IIoT

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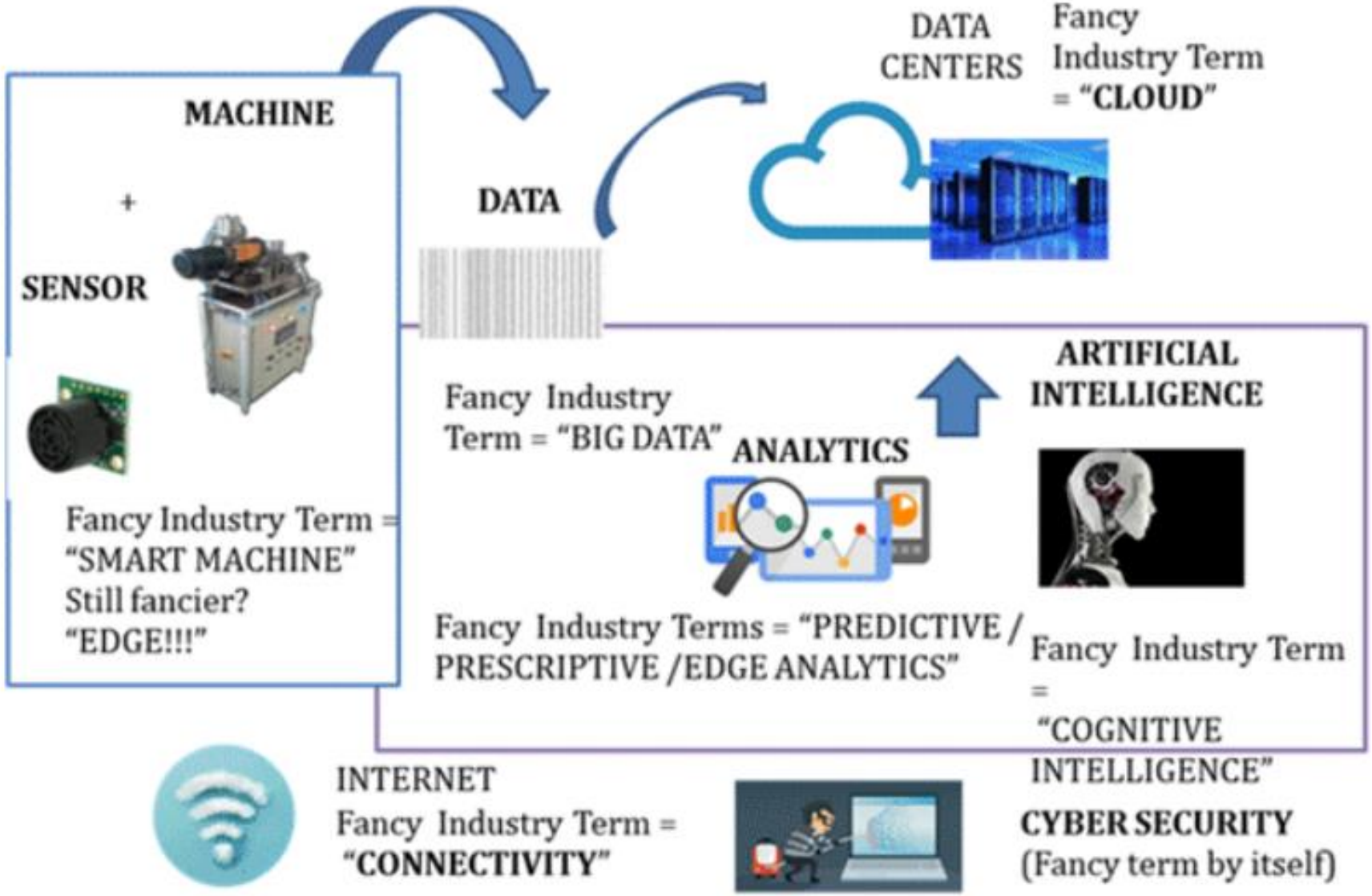
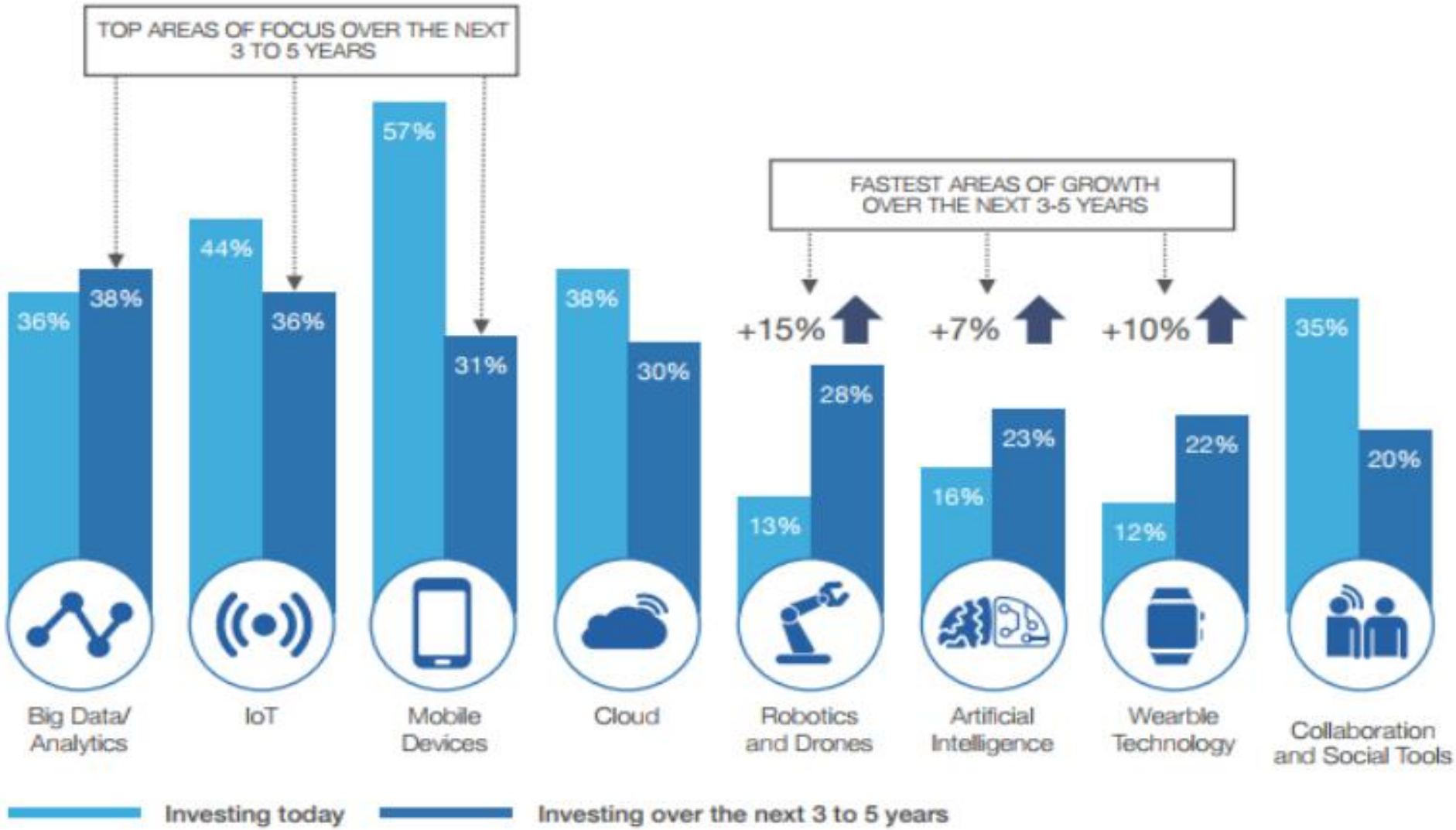



IoT Implementation in
Oil & Gas
© www.HiddenBrains.com


OIL AND GAS - industrial IoT and digital transformation
Industry experts on the evolutions, challenges, benefits and priorities

Investments in Digital Technologies



Oil & Gas Industry Introduction

Upstream

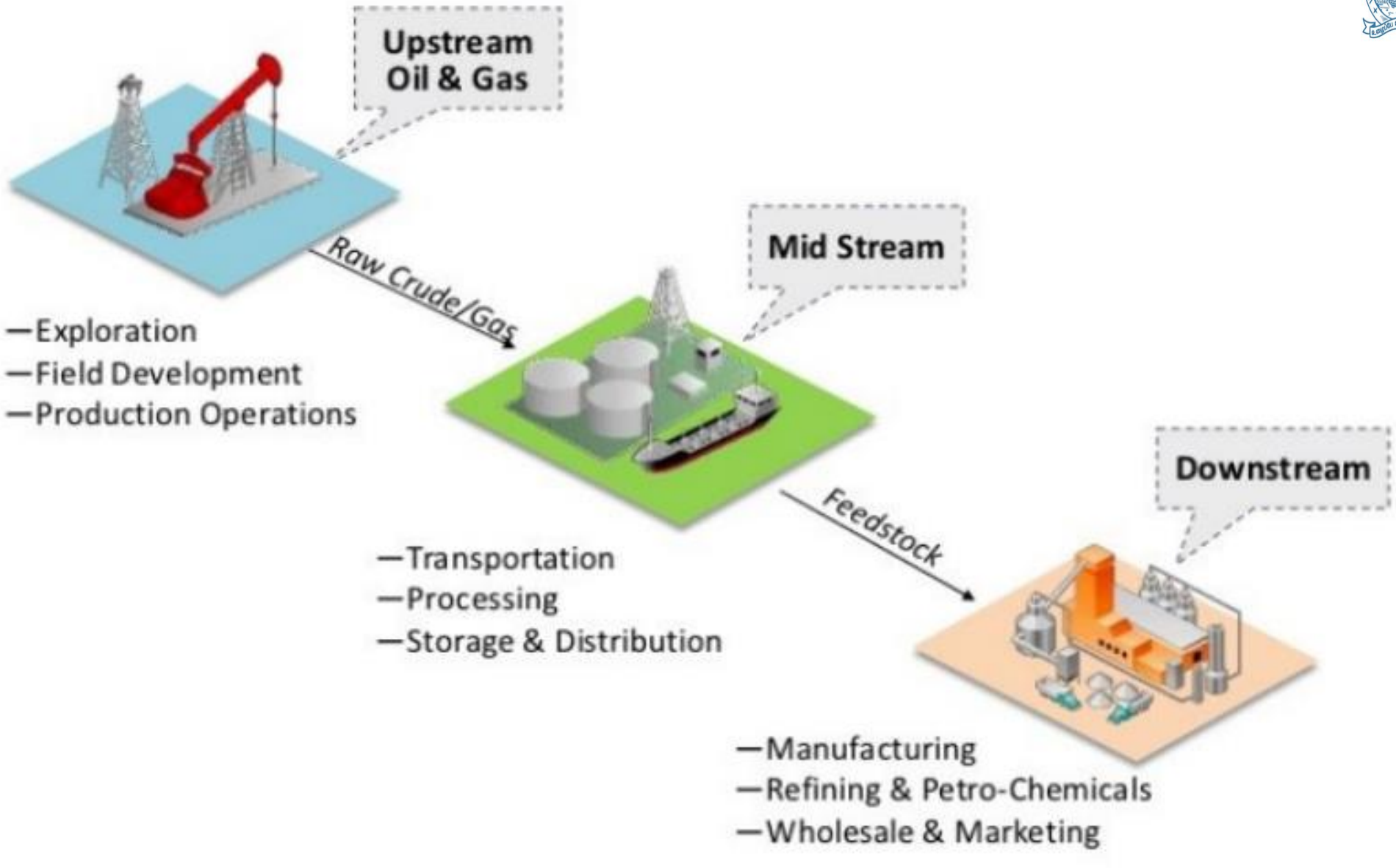
- Exploration & Production (E&P)
- Firms explore new hydrocarbon fields
- Discovered fields developed and petroleum produced

Midstream

- Transportation of oil and natural gas
- Shipping
- Pipelines
- LNG Terminals

Downstream

- Refinery processes crude oil to produce different products
- Petrochemical plants
- Polymers, Plastics and other products


Upstream
Oil & Gas
Raw Crude/Gas
—Exploration
—Field Development
—Production Operations
Mid Stream
—Transportation
—Processing
—Storage & Distribution
Feedstock
Downstream
—Manufacturing
—Refining & Petro-Chemicals
—Wholesale & Marketing

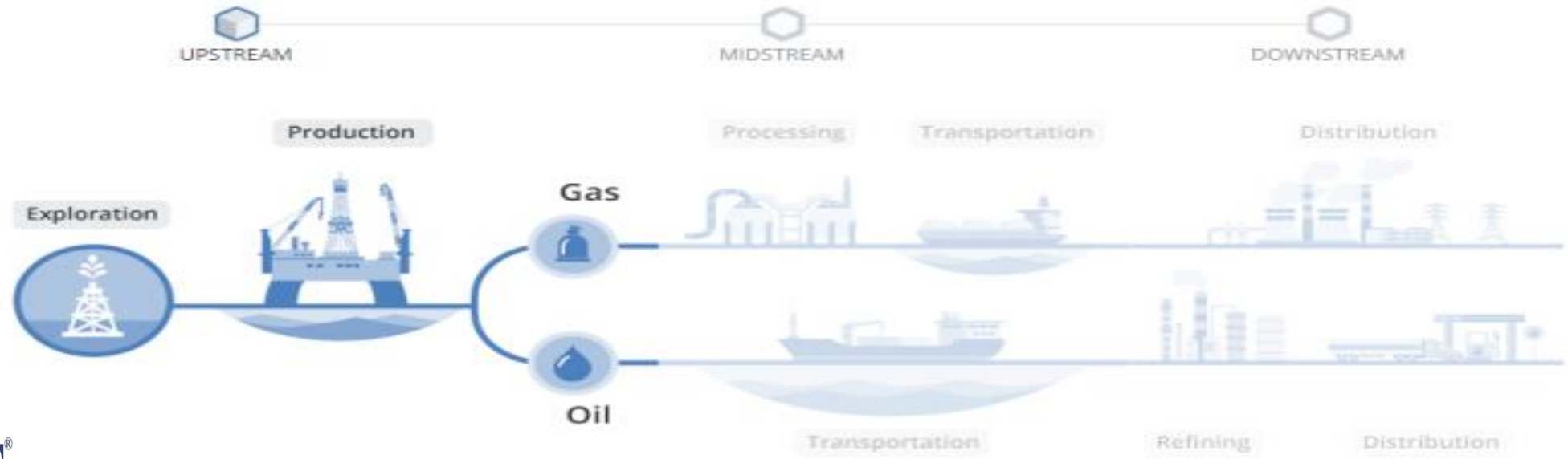
IoT Applications in Oil & Gas Industry (upstream)

The upstream industry Problem:

- loses billions of dollars every year due to nonproductive time (NPT)
- Deadly Accidents
- Processes are not optimized

IoT Solution:

- With the use of IoT, refineries can plan their shutdowns, minimize their downtime, and improve safety records
- Accidents can be prevented
- processes can be optimized



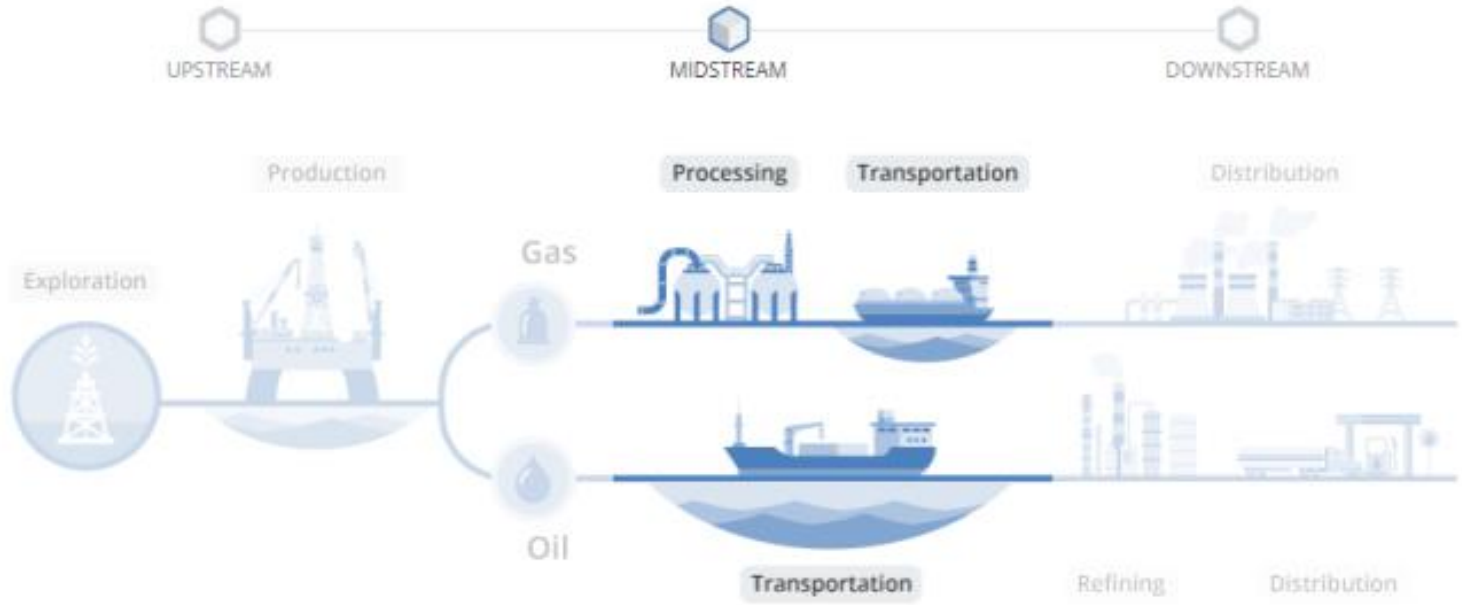
IoT Applications in Oil & Gas Industry (midstream)

The midstream industry Problem:

- has the challenging task of transporting variable volumes and grades of products from multiple locations to new end-users and markets
- Connecting pipeline networks, sensors, leak detection, alarms, and emergency shutdowns to interact seamlessly

IoT Solution:

- With the use of IoT, To be available for analysis and interpretation in real time would significantly reduce some of the major risks that this sector of the industry deals with



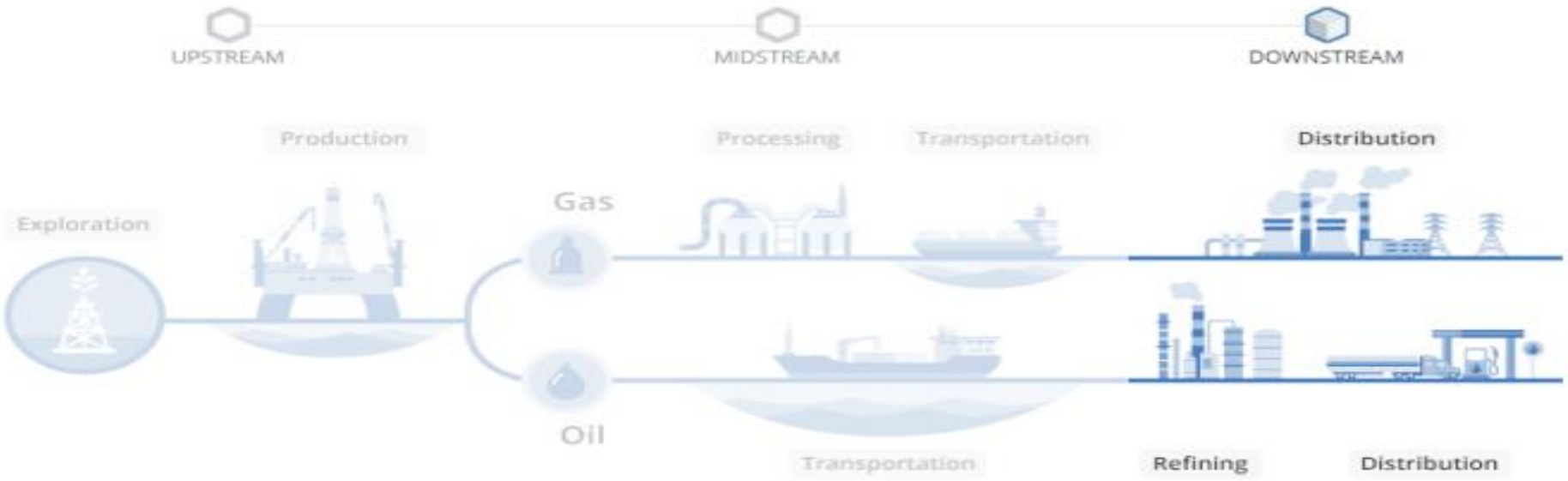
IoT Applications in Oil & Gas Industry (downstream)

The downstream industry Problem:

- Refinery shutdowns, handling various grades of crude oil, and changing environmental regulations are pushing gross refining margins down to a bare minimum

IoT Solution:

- With the use of IoT, refineries can plan their shutdowns, minimize their downtime, and improve safety records



There are countless opportunities for IoT Oil & Gas Industry

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Upstream	Midstream	Downstream
Asset Tracking	Tank Farm Monitoring	Perimeter Security Sensors
Vehicle Monitoring	Field Crew Monitoring	Perimeter Video Camera
Remote Video	Remote Video	Mobile Asset Tracking
Machine Monitoring	Pipeline Monitoring	Vehicle Monitoring
Site Monitoring	Terminal Access control	Production Sensors
Well Head Monitoring	Asset Tracking	IoT Cloud Storage
Security/Access Sensors	Flow Meter Connectivity	Lone Worker Wearables
Lone Worker Tracking	Pipeline Monitoring	Contractor Tracking
Rig Monitoring	Wellhead Monitoring	Refinery Monitoring
Tank Monitoring	Cargo Shipping Monitoring	

TECHNOLOGICAL CHALLENGES OF IoT

At present IoT is faced with many challenges, such as:

- Scalability
- Technological Standardization
- Inter operability
- Discovery
- Software complexity
- Data volumes and interpretation
- Power Supply
- Interaction and short range communication
- Wireless communication
- Fault tolerance

Verticals @ IOC

- Refineries
- Pipelines
- Marketing
- Petrochemicals
- Natural Gas…

Scope

- To balance the loss occurred due to **NPT or Non-Productive Time**.
  - IoT helps in connecting pipeline networks
  - Leak detection equipment using Sensors
  - Emergency / Planned shutdown
  - Managing various grades of crude

IoT PLATFORMS ON THE MARKET

- GE Predix
- Cisco IoT Cloud
- IBM Watson IoT
- PTC ThingWorx

GE PREDIX

- Uses a platform as a service (PaaS) model and is a cloud-based OS
- Built on Cloud Foundry, an open-source platform, and is optimized for secure connectivity and analytics at scale, both in the cloud and on the edge

CISCO IOT CLOUD

- Designed around six pillars of technology:
  - Network connectivity
  - Fog computing
  - Data analytics
  - Security (cyber and physical),
  - Management/automation, and
  - Application enablement.

Cloud addresses challenges across a wide variety of industries, including manufacturing, utilities, oil and gas, transportation, mining, and the public sector.

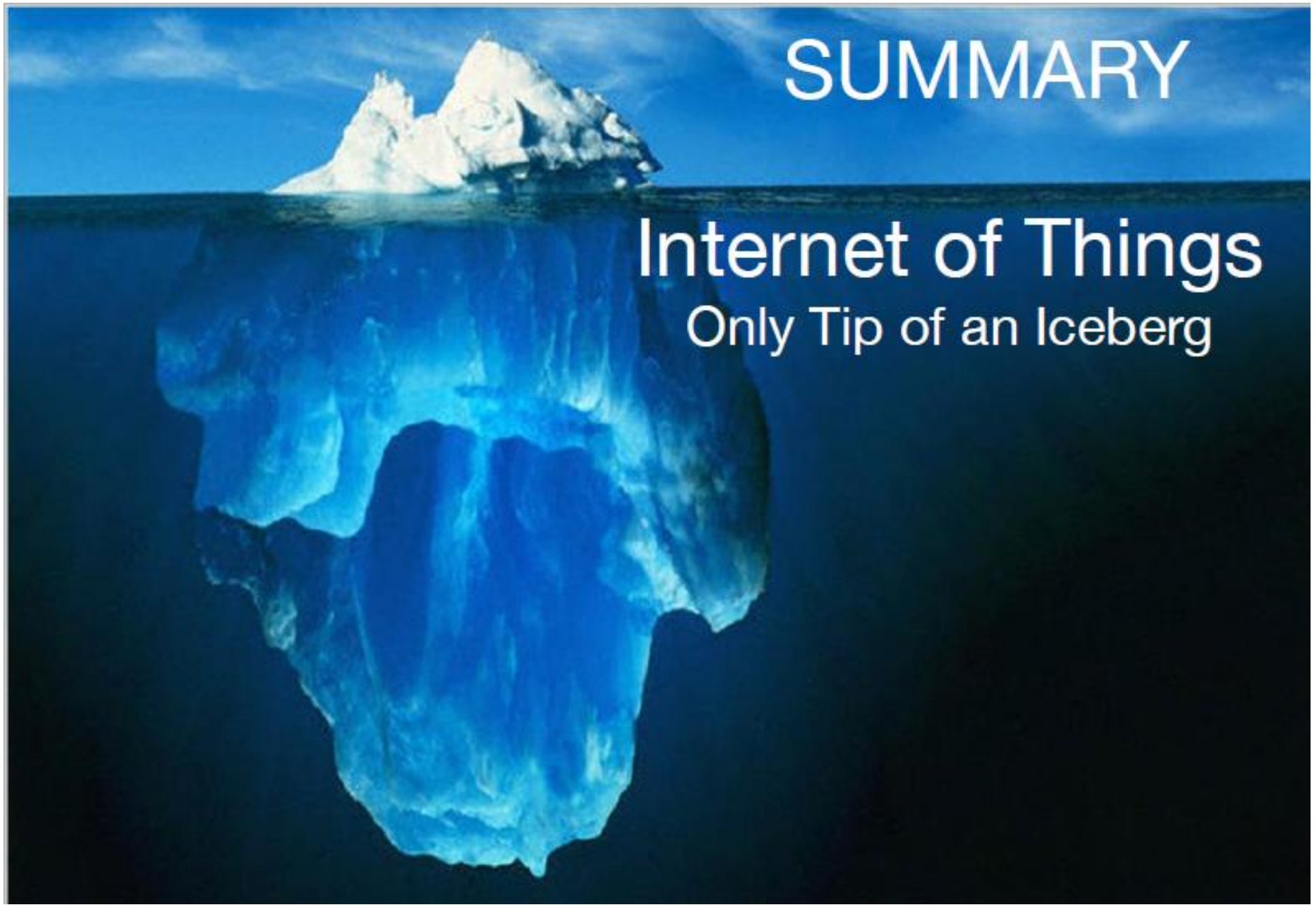
IBM WATSON IOT

Cloud Foundry, Docker®, OpenStack®, Watson IoT Platform development

Platform connects sensors to cloud applications using IBM Bluemix®

PTC® THINGWORX®

- **Three pillars of technology:**
  - Core application enablement
  - Connection services with device and cloud adopters, and
  - Edge connectivity using the Edge MicroServer and Edge “Always On” devices


SUMMARY
Internet of Things
Only Tip of an Iceberg

- Idnetify the ppalication
- Devices
- Simulate

References

1. https://en.wikipedia.org/wiki/Internet_of_Things
2. Cisco whitepaper, "The Internet of Things" - How the Next Evolution of the Internet Is Changing Everything, by Dave Evans, April 2011.
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