1. What is IOT ?

2. How IOT works ?

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What is IOT ?

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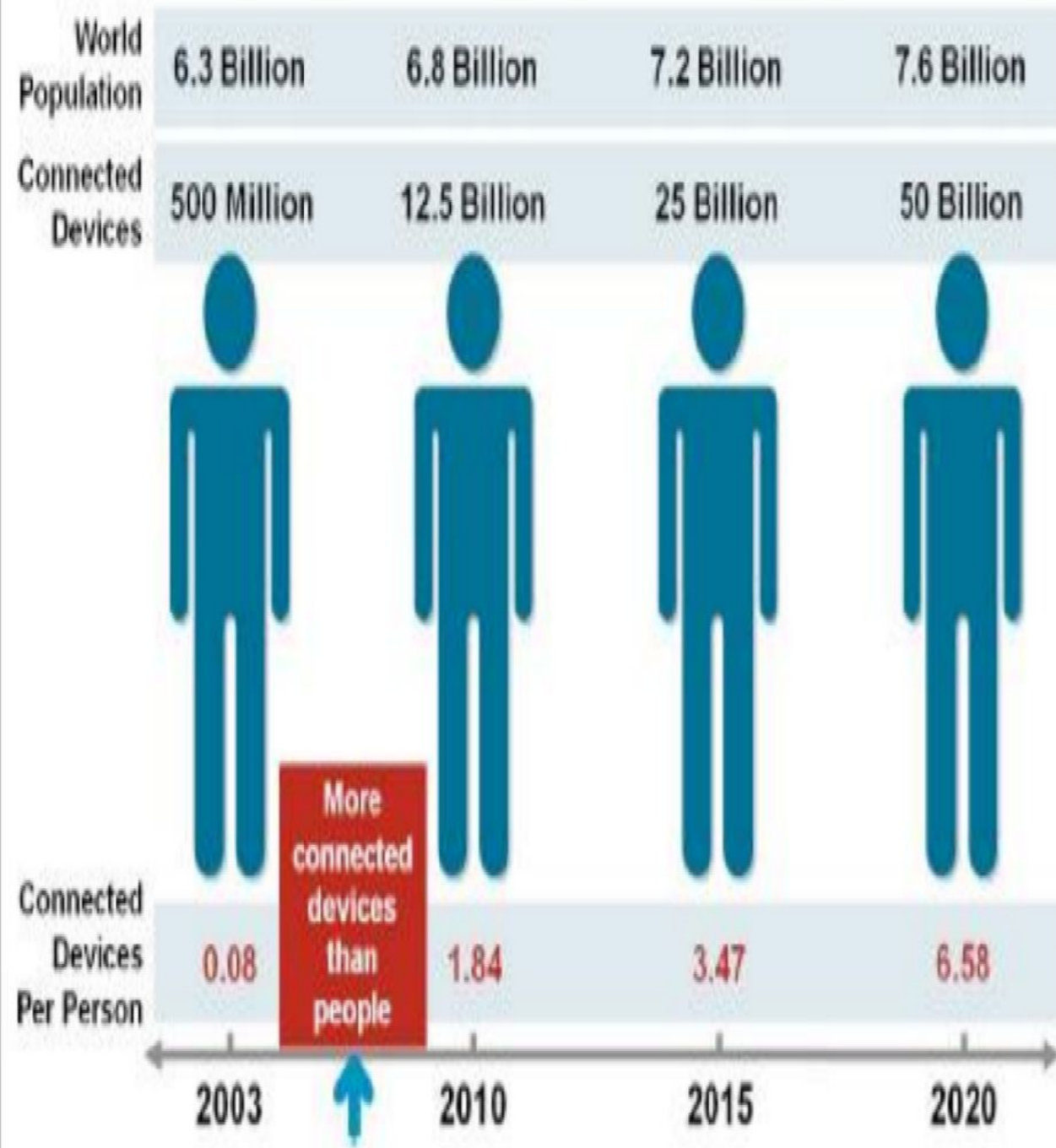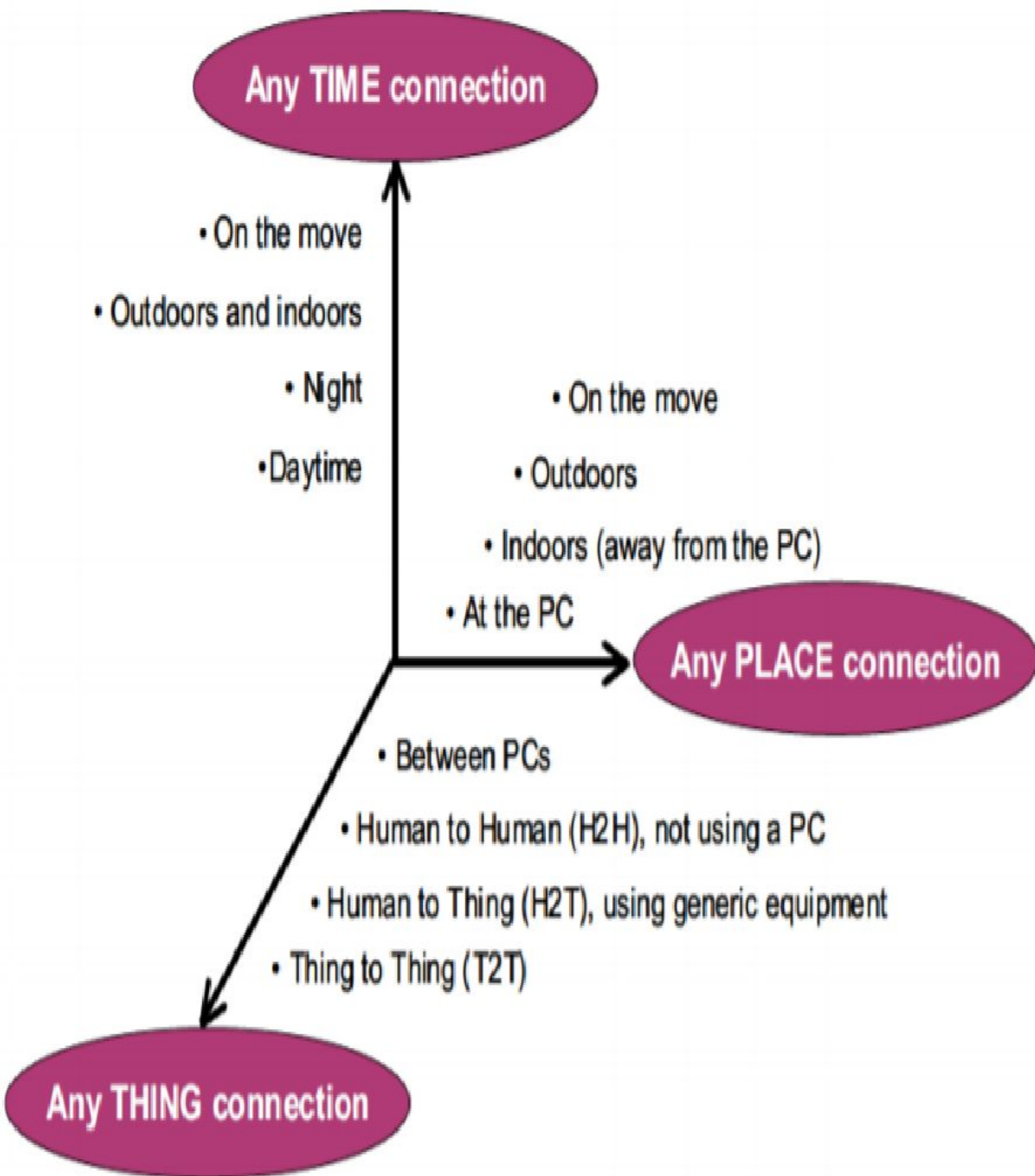

KEVIN ASHTON – "FATHER OF THE IOT"

"So you get stuff like the smart wine bottle, the smart bikini, and the smart water bottle. This stuff is not the Internet of Things – this stuff is all rubbish."
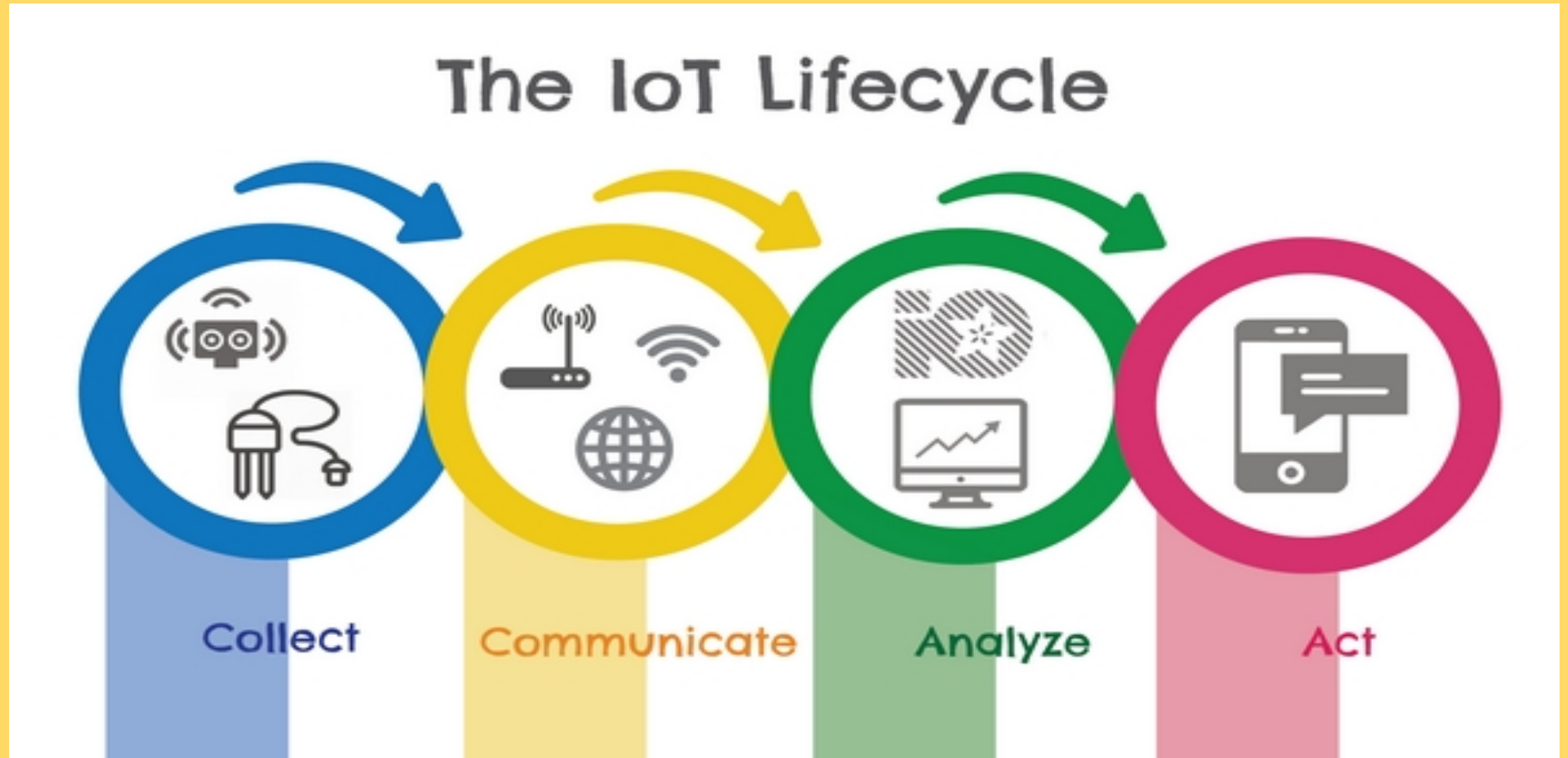
He believed IoT could "turn the world into data" that could be used to make macro decisions on resource utilization.

"Information is a great way to reduce waste and increase efficiency, and that's really what the Internet of Things provides"

[Source: The Reimagination Thought Leaders Summit ,Sydney, 17 November 2015]
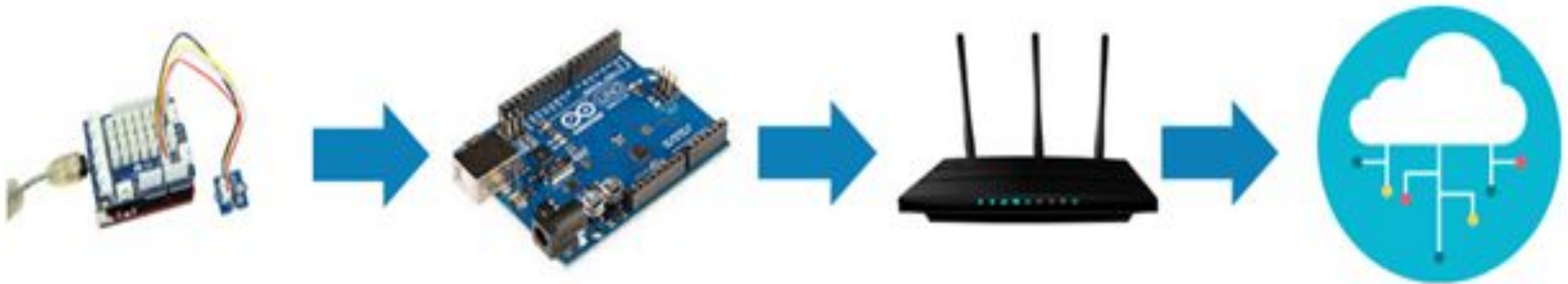
World Population	6.3 Billion	6.8 Billion	7.2 Billion	7.6 Billion
Connected Devices	500 Million	12.5 Billion	25 Billion	50 Billion

Any TIME connection

- On the move
- Outdoors and indoors
- Night
- Daytime

- On the move
- Outdoors
- Indoors (away from the PC)
- At the PC

Any PLACE connection

- Between PCs
- Human to Human (H2H), not using a PC
- Human to Thing (H2T), using generic equipment
- Thing to Thing (T2T)

Any THING connection

Connected Devices Per Person	0.08	More connected devices than people	1.84	3.47	6.58

2003   2010   2015   2020

How IOT works ?

The IoT Lifecycle

Collect → Communicate → Analyze → Act

IOT Architecture

Sensors/Actuators

- *Devices that are able to emit, accept and process data over the network.*

- *These sensors or actuators may be connected either through wired or wireless.*

- *This contains GPS, Electrochemical, Gyroscope, RFID, temperature Sensors, Radiation Sensors , Proximity Sensors etc.*

- *Most of the sensors need connectivity through sensors gateways.*

- *The connection of sensors or actuators can be through a Local Area Network (LAN) or Personal Area Network.*

Gateways and Data Acquisition

- As the large numbers of data are produced by this sensors and actuators need the high-speed Gateways and Networks to transfer the data.

- This network can be of type Local Area Network (LAN such as Wi-Fi, Ethernet, etc.), Wide Area Network (WAN such as GSM, 5G, etc.).

Edge IT

- Edge is the hardware and software gateways that analyze and pre-process the data before transferring it to the cloud.

- If the data read from the sensors and gateways are not changed from its previous reading value then it does not transfer over the cloud, this saves the data used.

Data center/ Cloud

- *The Data Center or Cloud comes under the Management Services which process the information through analytics, management of device and security controls.*

- *Beside this security controls and device management the cloud transfer the data to the end users application such as Retail, Healthcare, Emergency, Environment, and Energy, etc.*

The 4 Stage IoT Solutions Architecture
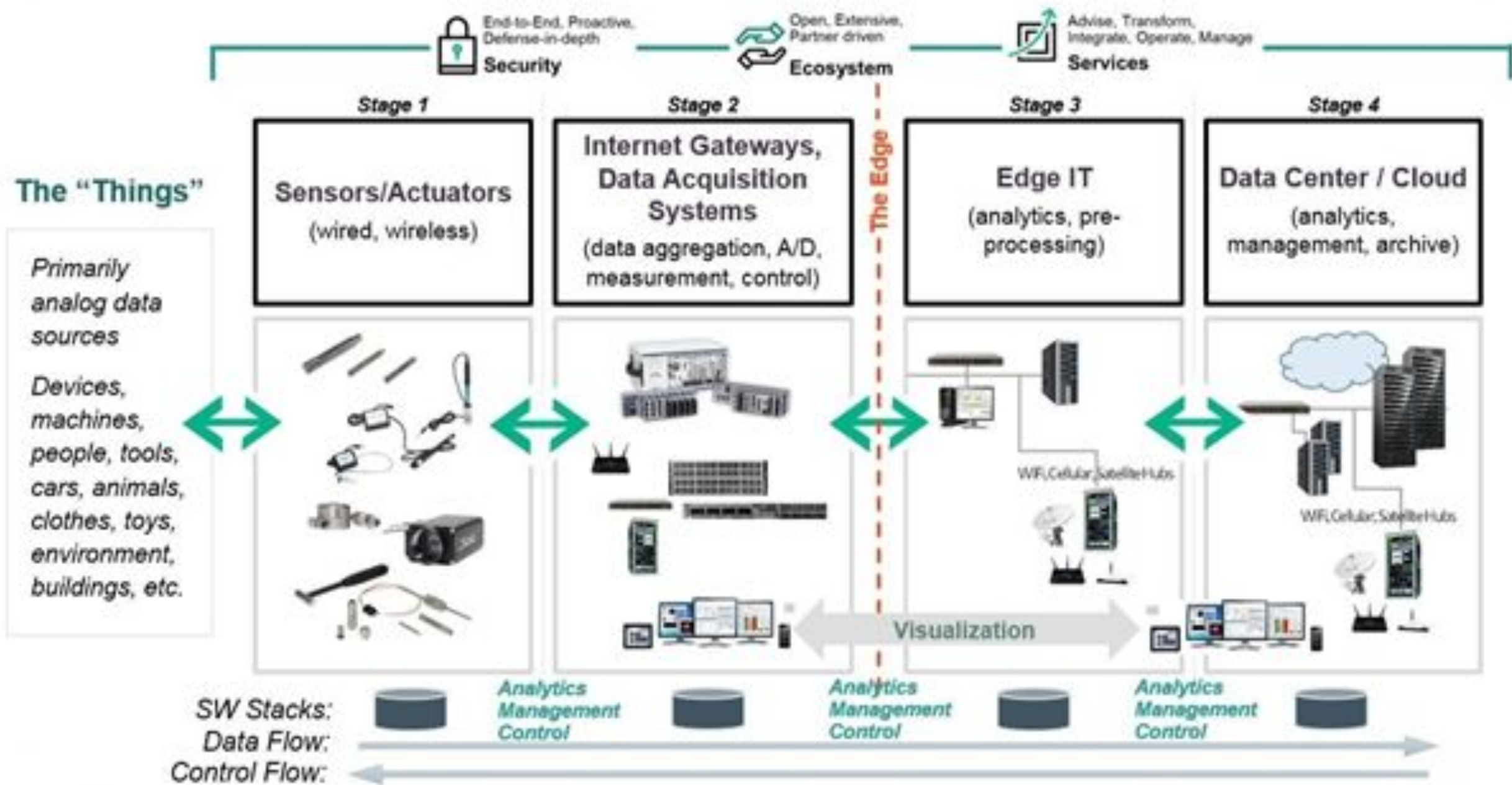
IoT layers
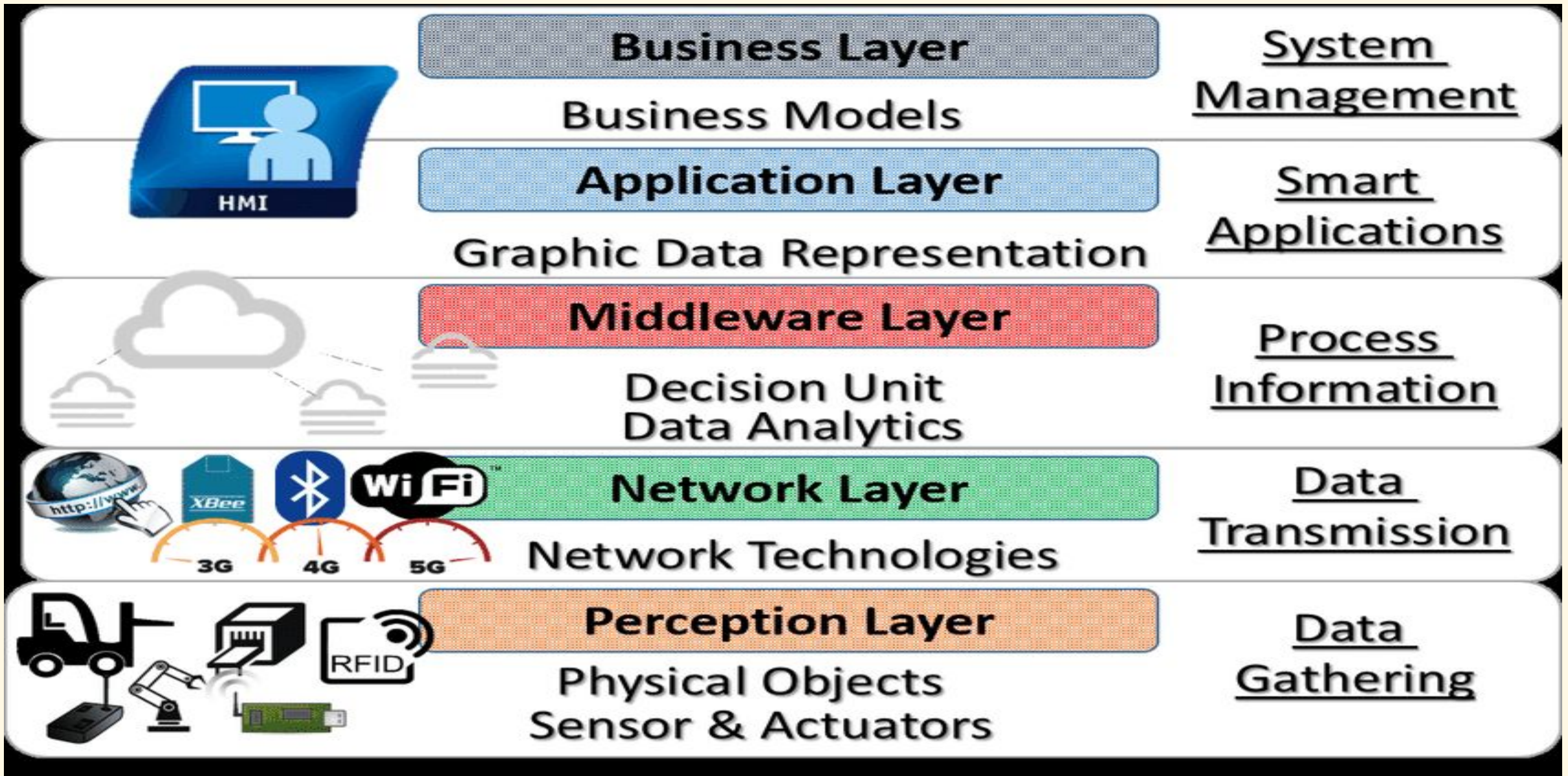
NETWORKING TECHNOLOGIES USED in IoT

Network	Connectivity	Pros and Cons	Popular use cases
Ethernet	Wired, short-range	☺ High speed ☺ Security ☹ Range limited to wire length ☹ Limited mobility	Stationary IoT: video cameras, game consoles, fixed equipment
WiFi	Wireless, short-range	☺ High speed ☺ Great compatibility ☹ Limited range ☹ High power consumption	Smart home, devices that can be easily recharged
NFC	Wireless, ultra-short-range	☺ Reliability ☺ Low power consumption ☹ Limited range ☹ Lack of availability	Payment systems, smart home
Bluetooth Low-Energy	Wireless, short-range	☺ High speed ☺ Low power consumption ☹ Limited range ☹ Low bandwidth	Small home devices, wearables, beacons
LPWAN	Wireless, long-range	☺ Long range ☺ Low power consumption ☹ Low bandwidth ☹ High latency	Smart home, smart city, smart agriculture (field monitoring)
ZigBee	Wireless, short-range	☺ Low power consumption ☺ Scalability ☹ Limited range ☹ Compliance issues	Home automation, healthcare and industrial sites
Cellular networks	Wireless, long-range	☺ Nearly global coverage ☺ High speed ☺ Reliability ☹ High cost ☹ High power consumption	Drones sending video and images

altexsoft
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- HTTP
- CoAP
- WebSocket
- MQTT
- XMPP
- DDS
- AMQP

HTTP

- Hyper text transfer protocol

- GET, PUT, POST, DELETE, HEAD, TRACE, OPTIONS, etc commands.

- Stateless (each request is different of others)

- HTTP client can be a browser or application running on the client Multiple headers such as Multipurpose Internet Mail Extensions (MIME)

http method	Resource type	action	Example
GET	Collection URI	List all the rescuers in a collection	http://example.com/api/tasks (list all tasks)
GET	Collection URI	Get info about a resource	http://example.com/api/tasks (get info on task 1)
POST	Collection URI	Create a new resource	http://example.com/api/tasks (create a new task from the data provided in the req)
POST	Collection URI	Generally not used	
PUT	Collection URI	Replace the entire collection with another collection	http://example.com/api/tasks (replace entire collection with data provided in the request)
PUT	Collection URI	Update a resource	http://brample.com/api/tasks (delete all tasks)
DELETE	Collection URI	Delete the entire collection	http://example.com/api/tasks (lista ll tasks)
DELETE	Collection URI	Delete a resource	http://example.com/api/tasks (del task 1)

WEBSOCKET

▸Full Duplex communication over single socket connection for sending messages between client and server.

▸ It is based on TCP.

▸ Client can be a browser, IoT Device or a mobile application.
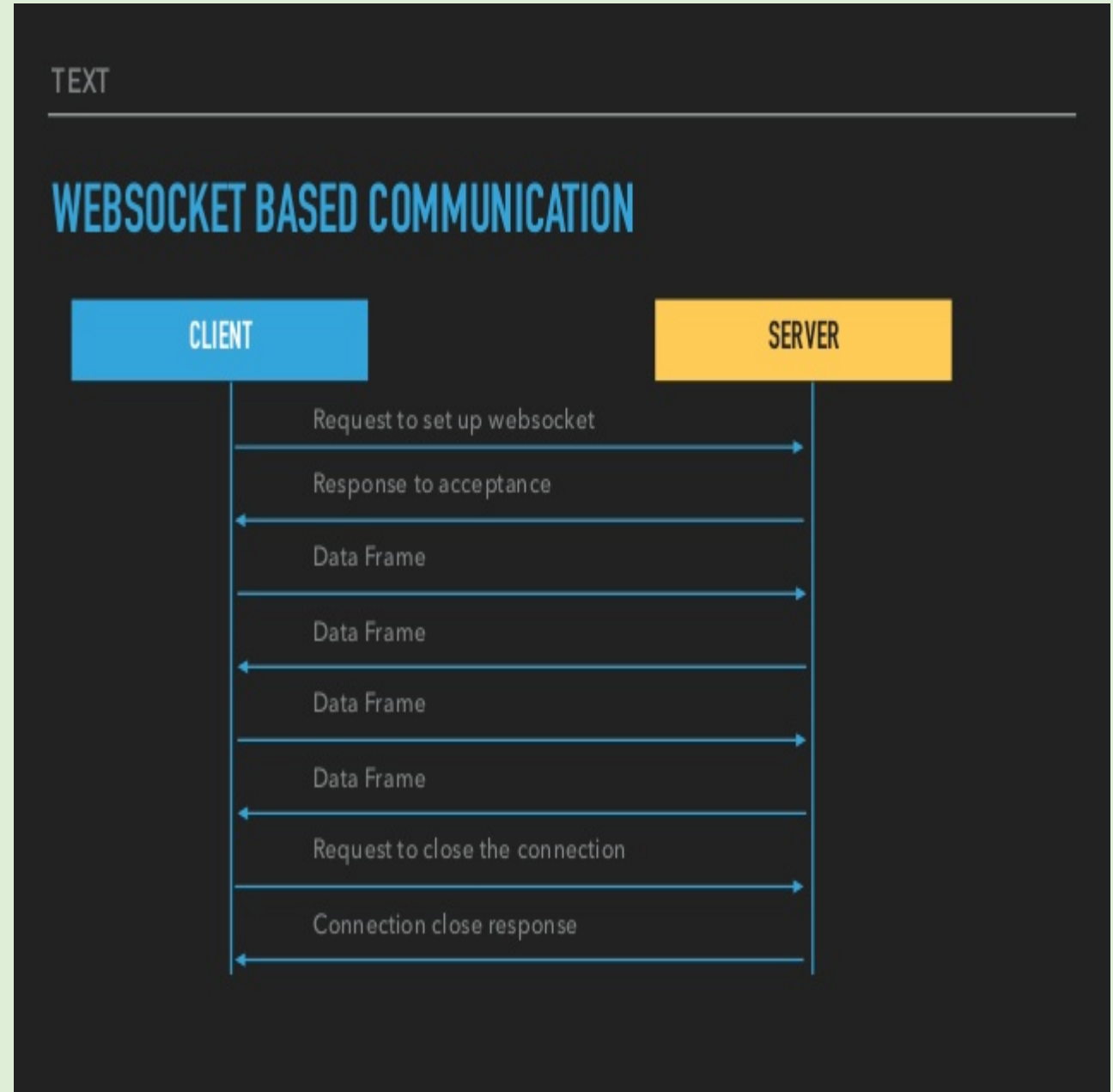
MQTT

- Message Queue Telemetry Transport
- based on subscriber, publisher and broker model.
- Use of MQTT broker (as a Server)
- Useful for places where memory and resources constraints are limited

MQTT responds well to the following needs:

- Minimum bandwidth use
- Operation over wireless networks
- Low energy consumption
- Little processing and memory resources

Pros

- **Very lightweight**
- **Ensures message delivery**
- **Battery friendly**

Cons

- **Doesn't support streaming**
- **Not 'developer friendly'**
- **Latency issues**

XMPP

- Extensible Messaging and Presence protocol.

- Real time communication and streaming xml data between network elements.

- Suitable for Voice/Video chats, messaging, data syndication, gaming, multi party chat.

- Its based on client server architecture as well as server - server architecture.

DDS

- Data Distribution service

- Its a middleware for D2D or M2M.

- Publish subscribe model

- Provides QoS and configurable reliability.

- Finds its application in some Industrial Internet of Things deployments, such as: air-traffic control, power generation, and healthcare services.

AMQP

- Advanced message queuing protocol

- It is for business

- messaging Supports point to point and publish subscribe, routing/queuing

- Uses AMQP brokers

- Messages are pushed by the brokers or pulled by the consumers.

- Due to its heaviness, AMQP is not suitable for sensor devices with limited memory, power or network bandwidth.

Pros
- *It uses QoS to ensure message delivery*
- *Adaptable to other IoT standards*

Cons
- *Heaviness*
- *Not user friendly*

CoAP

- Constrained Application Protocol

- was designed to translate the HTTP model so that it could be used in restrictive device and network environments.

- For Machine to Machine M2M Request response model

- Runs on UDP instead of TCP

- GET , PUT, POST, DELETE, etc.

- Features Quality of Service which is used to control the messages sent and mark them as 'confirmable' or 'non-confirmable' accordingly which indicates whether the recipient should return an 'ack' or not.

Pros
Low overheads
Encryption

Cons
Message unreliability
Issues with NAT and firewalls

Characteristics of IOT

- *Small devices*
- *Unique Identity*
- *Dynamic nature*
- *Adaptability*
- *Integrated to Information Network*
- *Connectivity*

Benefits

- Efficient resource utilization

- Saves time

- Less Human efforts & errors

- Security

- Easy to use (User friendly)

Security Problems

- DOS

- DDOS

- Unauthorized access

- Information manipulation

- Information disclosure

Applications

- Smart home
- Iot in agriculture
- Energy engagement
- Transport and logistics
- Smart Electricity management
- Building and Home automation
- Manufacturing
- Medical and Healthcare systems
- Media
- Environmental monitoring
- Infrastructure management
- Energy management

Various Platforms for IoT

1.   Google Cloud Platform

- Provides a multi-layered secure infrastructure.
- It helps in improving operational efficiency. Also provides predictive maintenance for equipment, solutions for smart cities & buildings, and real-time asset tracking.

Features:

- Machine learning capabilities for any IoT need.
- Real-time business insights for globally dispersed devices.
- AI capabilities.
- Provides support for a wide range of embedded operating systems.
- Location intelligence.

Cost: Price starts at $1758 per month.

Verdict: Organizing, managing, and sharing documents is easy. It works with all operating systems. Overall it provides good features and functionalities and ease of use.

Website: Google Cloud Platform

2. OpenRemote

100% open-source IoT platform to create a wide range of applications.

They are adopted in larger professional IoT applications for e.g. energy management, crowd management.

Features:

- IoT-based protocols like HTTP, TCP, UDP, WebSocket or MQTT, to connect your IoT devices, gateways, or data services or build a missing vendor-specific API.
- Other protocols such as KNX (Konnex).
- Rules engine with a Flow editor, a WHEN-THEN.
- Dashboard for provisioning, automating, controlling, and monitoring your application as well as Web UI components to build project-specific apps.
- Mobile app for Android and iOS, including the option to use geofencing and push notifications.
- Edge Gateway solution to connect multiple instances with a central management instance.
- Ability to create multi-realms combined with account management and identity service.

Costs: Completely free under open source license.

Verdict: Not as feature-rich as it is paid for big services, but very impressive as it contains all you need, it's free and seems to be trusted by larger users.

3. IRI Voracity

Voracity is a fast, affordable platform for data discovery, integration, migration, governance, and analytics that can transform, report, and anonymize device data streaming through Kafka or MQTT.

Features:

- Connects to and integrates sensor, log, and many other data sources.
- Consolidated (same I/O) data filtering, transformation, cleansing, masking, and reporting.
- Runs on a wide range of Linux, Unix, and Windows platforms, from a Rasberry Pi to a z/Linux mainframe.
- Migrates, replicates, subsets, and otherwise leverages IoT data for archival, data lakes, analytics.
- Fit-for-purpose data-wrangling node to aggregate and anonymize IoT data and feed IOT mining and machine learning nodes.
- App, add-on, and Universal Forwarder options for fast preparation and direct indexing of Splunk for cloud analytics and action on IoT data.

Cost: 3-5 figures per hostname per year; depending on the components and volumes needed.

Verdict: Very versatile, high-speed data manipulation engine and platform to integrate, govern, and analyze IoT data, on the edge or in the hub.

4. Particle

Particle provides the IoT solutions for hardware, connectivity, device cloud, and apps.

Features:

- It will provide a robust and reliable infrastructure.
- This platform can be used by anyone. No need for expertise.
- It provides the firewall-protected cloud.
- It can work with data even if it is on Microsoft Azure, Google Cloud etc.
- For data, it can be integrated with anything using REST API.
- It provides an all-in-one solution for the hardware, software, and connectivity. There will be no need to invest time again in integrating.

Cost:

- **For Wi-Fi:** Price starts at $25 per device.
  For Cellular: Price starts at $49 per device.
  For Mesh: Price starts at $15 per device.

Verdict: It is user-friendly and easy to learn. Good community support is available for Particle.

5. *ThingWorx*

- It helps in managing the development lifecycle for IoT applications.
- It provides flexibility to access data and IoT from on-premise, off-premise, and from the hybrid environment.

Features:

- Connect devices.
- Analyze data.
- Build and deploy solutions.
- Industrial IoT and application data is accessible from on-premise web servers, off-premise cloud applications and as hybrid environments.

Cost: Contact them for pricing details.

Verdict: It is a good solution for industrial IoT. With the help of ThingWorx, you can create an industrial IoT application fast. There is no need to write too many lines of code.

6. IBM Watson IoT

- This platform will help you to capture and investigate the data for devices, machines, equipment and find out the understandings for better decisions.

- This platform will allow you to optimize operations and resource.

Features:

- AI and Analytics.

- Domain expertise.

- Provides flexible solutions.

- Provides security.

- Captures real-time data.

- Provides analytics service as an add-on.

Cost: Starts at $500 per instance/month.

Verdict: Platform provides good features and functionalities at an affordable price.

7. Amazon AWS IoT Core

- It is a managed cloud service.
- AWS IoT Core will allow devices to connect with the cloud and interact with the other devices and cloud applications.

Features:

- It can process a huge amount of messages.
- It is a reliable and secure platform to route the messages to AWS endpoints and other devices.
- Your applications will track and communicate even when not connected.
- You will be able to use other AWS services like AWS Lambda, Amazon Kinesis, and Amazon QuickSight etc.
- It allows secure access to your devices.

Cost: Contact for more pricing details. 12 months free trial period is also available.

Verdict: You can start in just three simple steps. Signup, learn from tutorials and start building. Tutorials are provided as a learning material.

8. Microsoft Azure IoT Suite

- This IoT solution is designed for different industry needs. It can be used from manufacturing to transportation to retail.
- It provides solutions for remote monitoring, predictive maintenance, smart spaces, and connected products.

Features:

- It provides you with an open platform to build a robust application.
- It can be used by beginners as well as experts.
- There are two solutions to start with, as an IoT SaaS and with open source IoT Templates.

Cost: Contact them for pricing details.

Verdict: A free guide is provided on how to create IoT applications. The platform provides a good number of features and functionalities and it is easily scalable too.

9. Oracle IoT

- It supports integration with Oracle and non-oracle applications and IoT devices using REST API.

Features:

- It will allow you to create an IoT application and connect a device to JavaScript, Android, iOS, Java, and C.

- It will help you to extend the supply chain, ERP, HR, and customer experience applications.

- Operational efficiency and worker productivity will be improved.

- It provides features like device virtualization, high-speed messaging, and endpoint management to connect.

- To analyze the data, it provides features like stream processing and data enrichment.

- Using REST API, integration can be done with Oracle and non-oracle applications and IoT devices.

Cost: Price starts at $2.2513 per hour on a monthly basis. These prices are for Universal Credit services. For non-metered services, the prices start at $2500.

Verdict: It is a cloud-based service and is easy to use. It provides an integration option with Oracle and non-Oracle applications.

10. Cisco IoT Cloud Connect

- Cisco IoT cloud connect is a mobility cloud-based software suite. This IoT solution is for mobile operators. It will fully optimize and utilize the network. Cisco provides IoT solutions for networking, security, and data management.

Features:

- Granular and real-time visibility.

- It provides updates for every level of the network.

- For IoT security, it provides benefits of protecting the control system from human errors & attacks, increased visibility & control by defending malware and intrusion, and centralized security controls.

Cost: Contact for the pricing details.

Verdict: Cisco IoT cloud connect is for networking, security, and data management and provides updates at every level of the network.

11. Altair SmartWorks

- It will help you to connect devices, collect data, manage devices and data, and build and run the app. It provides functionalities like device management, Listeners, rules, custom alarms, triggers, and data export etc.

Features:

- Using SmartWorks you can connect with any devices like sensors, gateways, machines, etc.

- Using REST API, you can send XML or JSON data.

- It has an open architecture.

Cost: Free for two devices. For more details contact them.

Verdict: Platform is easy to use and provides good features and functionalities.

12. Salesforce IoT Cloud

- Salesforce IoT cloud will help you to transform all data which is generated by the customers, partners, devices, and sensors into relevant actions. It has partner connectors like AWS, Cisco Systems, etc.

Features:

- It allows you to test business ideas without programming.
- It will provide you the real data about the product usage and performance.
- It can work with the data from any device.
- You can create device profiles for customer context data in CRM and for streaming data from the connected devices.
- Using RESTful API, you can import data from any source.
- No need of CS degree while creating and managing orchestration rules.
- Real-time traffic view.

Cost: Contact for the pricing details.

Verdict: Tool provides a good interface, ease of use etc. CRM in the cloud will allow people to work from anywhere.

Real-World IoT Examples

1. IoT Sensors : https://youtu.be/ysUXi8RyLAA

2. IoT Data Analytics : https://youtu.be/-NYlODhZbys

3. IoT Tracking and Monitoring System : https://youtu.be/zFn487G2pY8

4. IoT Connected Factory : https://youtu.be/QLdFZh2SjtA

5. Smart Supply Chain Management : https://youtu.be/jKzw_-dS1jk

6. Smart Barcode Readers : https://youtu.be/MDkIBjqgJJ8

7. Smart Grids : https://youtu.be/JwRTpWZReJk

8. Connected HealthCare System : https://youtu.be/WzEf0IE_kMk

9. Smart Farming : https://youtu.be/LaMvMgdJC58