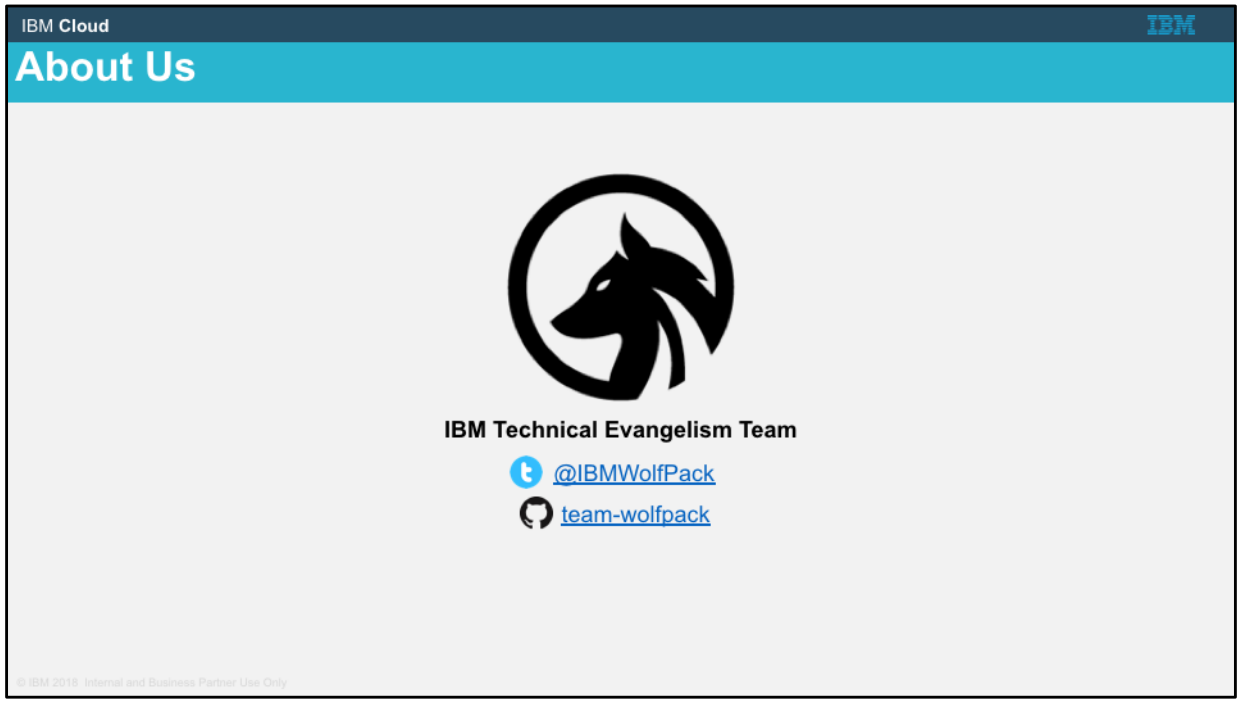
Edge Computing and the Internet of Things

NA Partner Channels – IBM Cloud
Technical Evangelism Team

Agenda

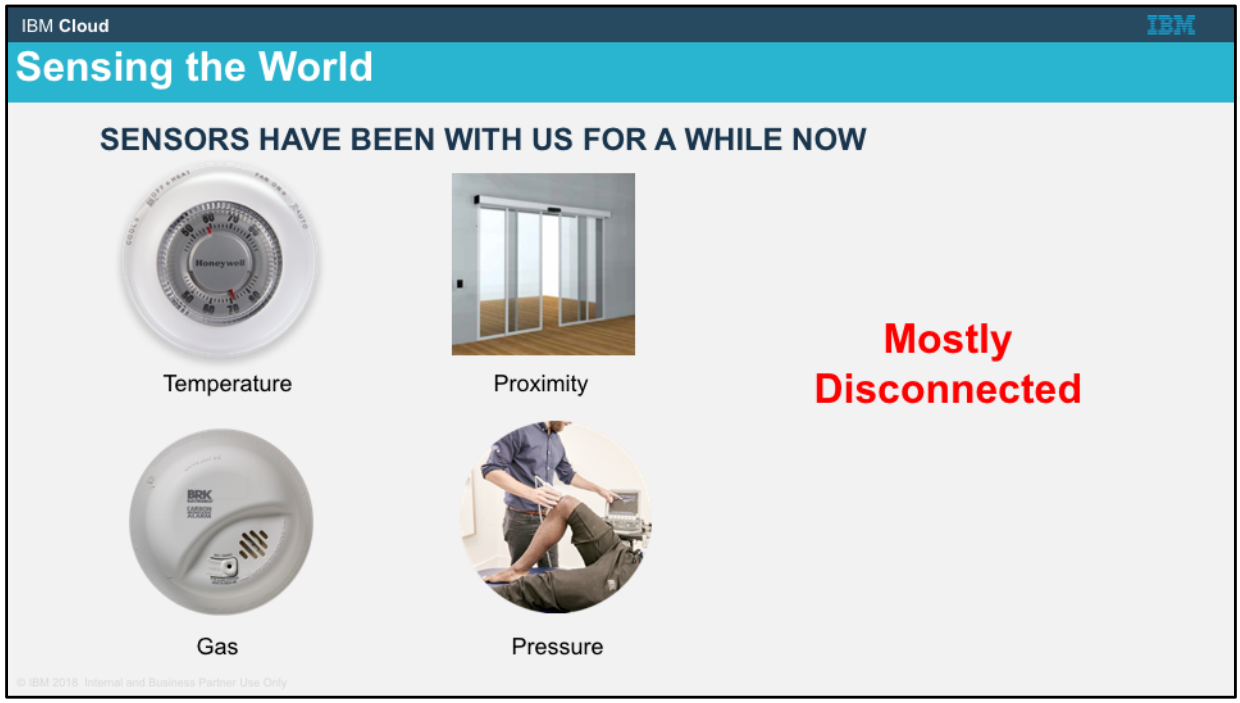
1. Introduction
2. Sensing the World
3. Internet of Things (IoT)
4. Computing at the Edge
5. IoT Technologies



The IBM WolfPack is the technical innovation team dedicated to making it easy for you to find the right platform, tools, and education so you can change the world.

Sensing the World

Sensors are not a new concept



https://www.finoit.com/blog/top-15-sensor-types-used-iot/

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https://complete-physio.co.uk/wp-content/uploads/2017/09/ULTRASOUND-GUIDED-INJECTION.png

https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/

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Sensing the World

NECESSITY IS THE MOTHER OF INVENTION

The First “Connected” Device

- Carnegie Mellon (1982)
- Computer Science Department
- Lazy Graduate Students
- Wired Coke Machine (can count, temp)
- Communication via ARPNET

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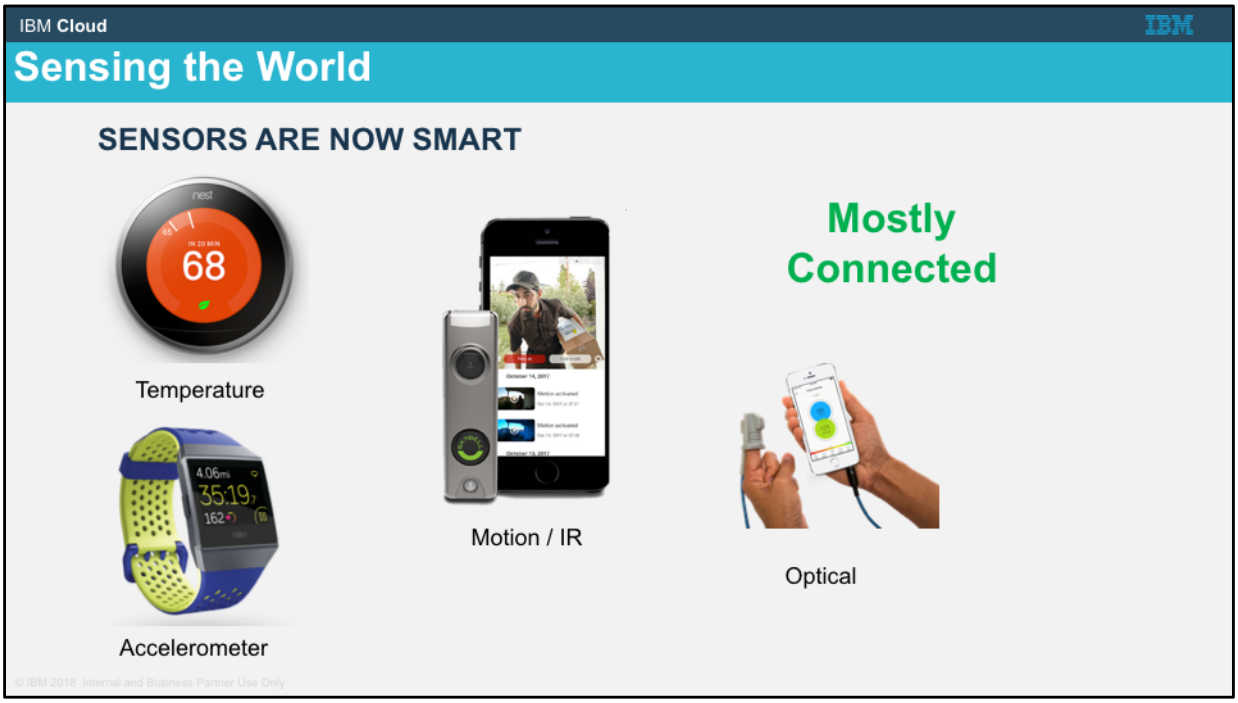
https://www.cs.cmu.edu/~coke/history_long.txt
https://connectedworld.com/the-evolution-of-smart-coca-cola-vending-machine/



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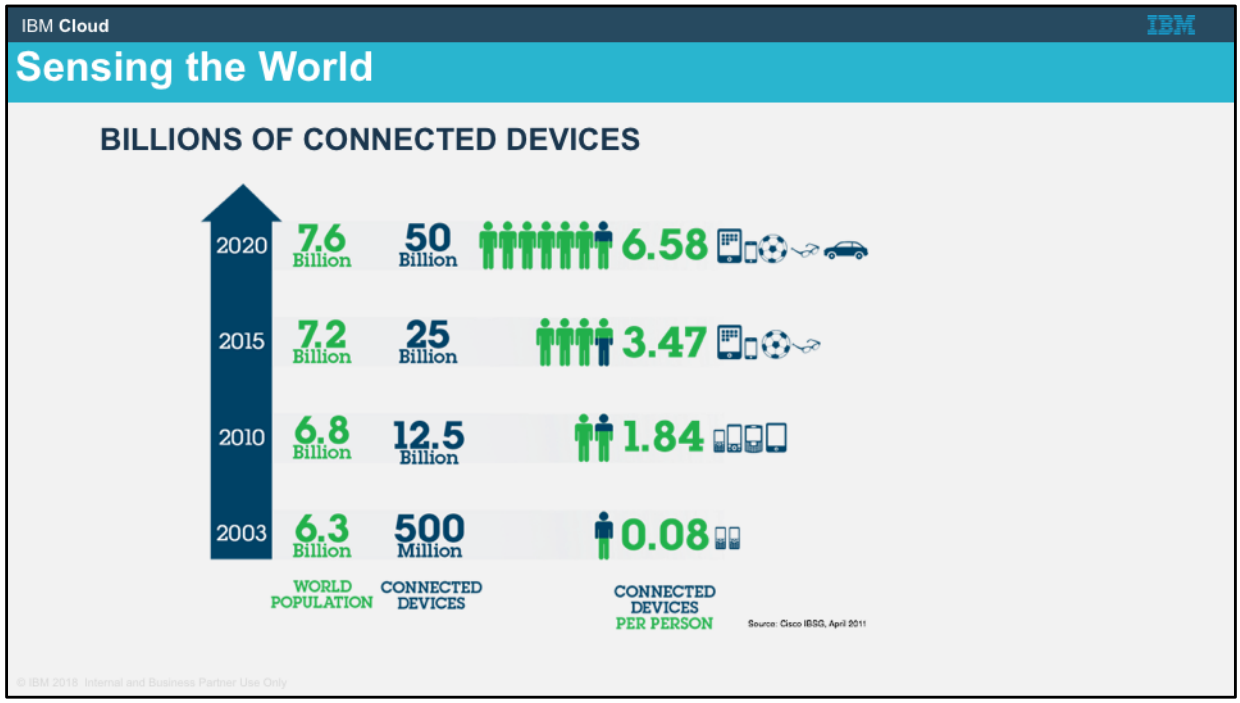

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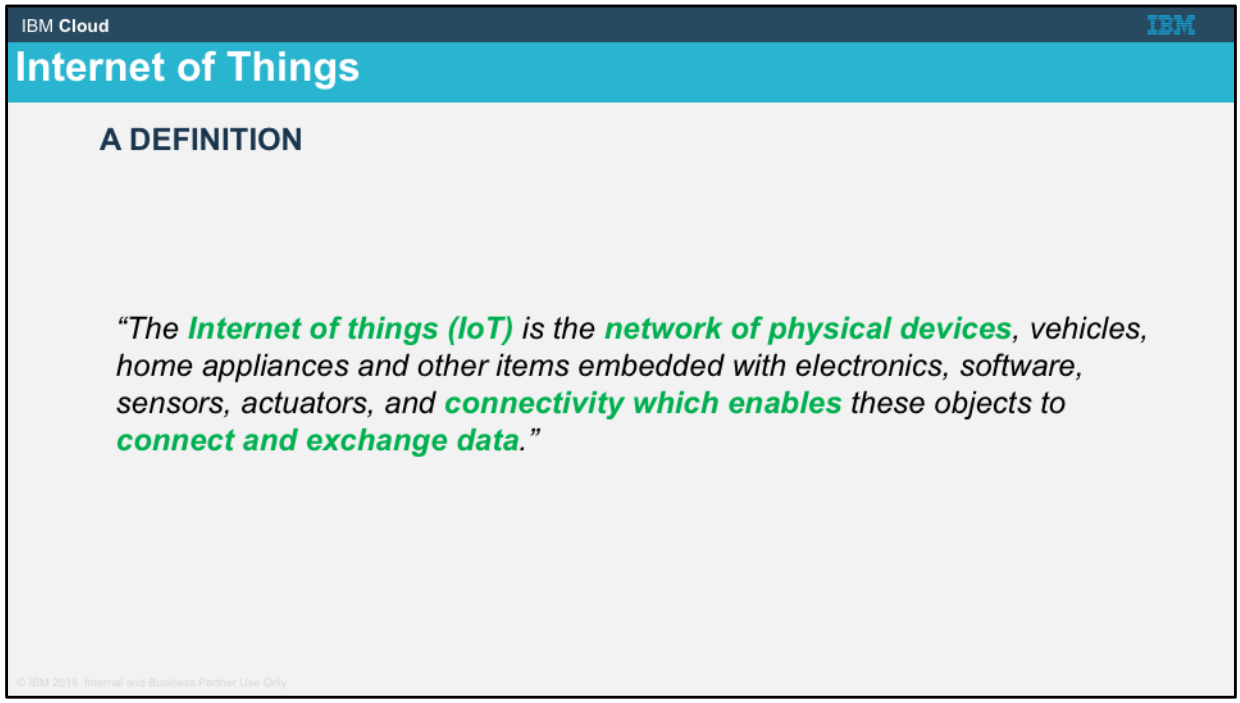
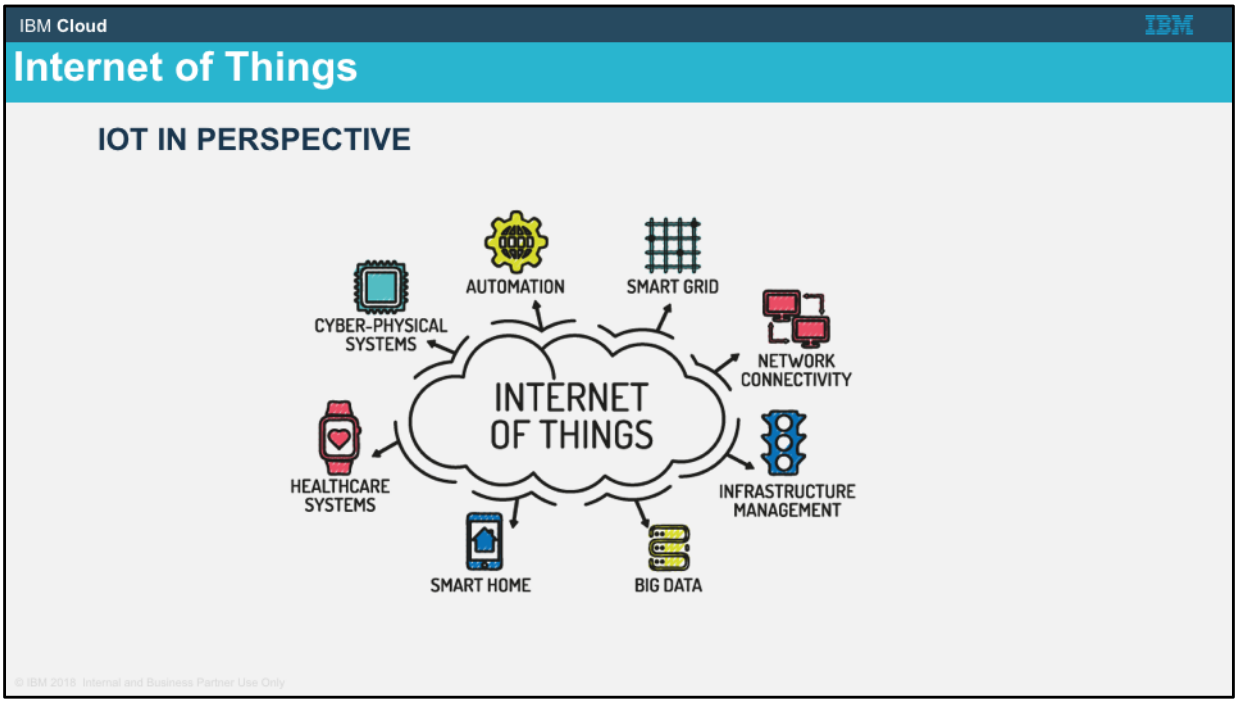
Internet of Things (IoT)



https://en.wikipedia.org/wiki/Internet_of_things

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.



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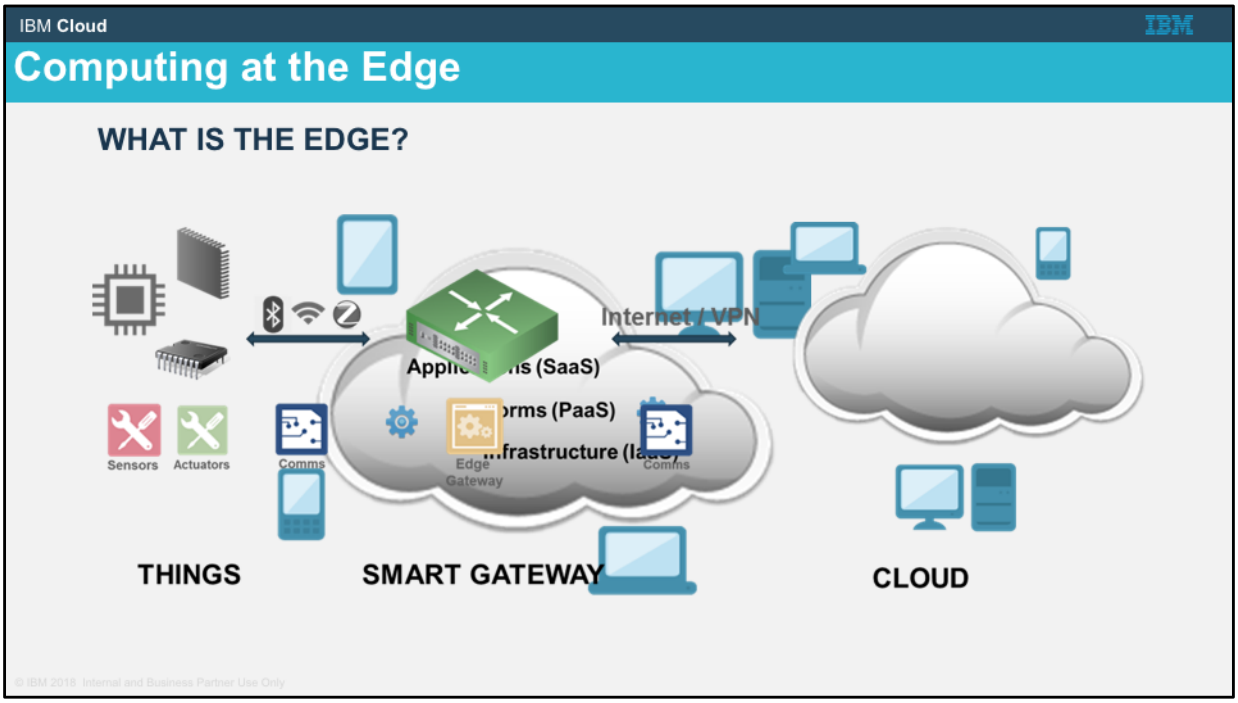
Computing At the Edge



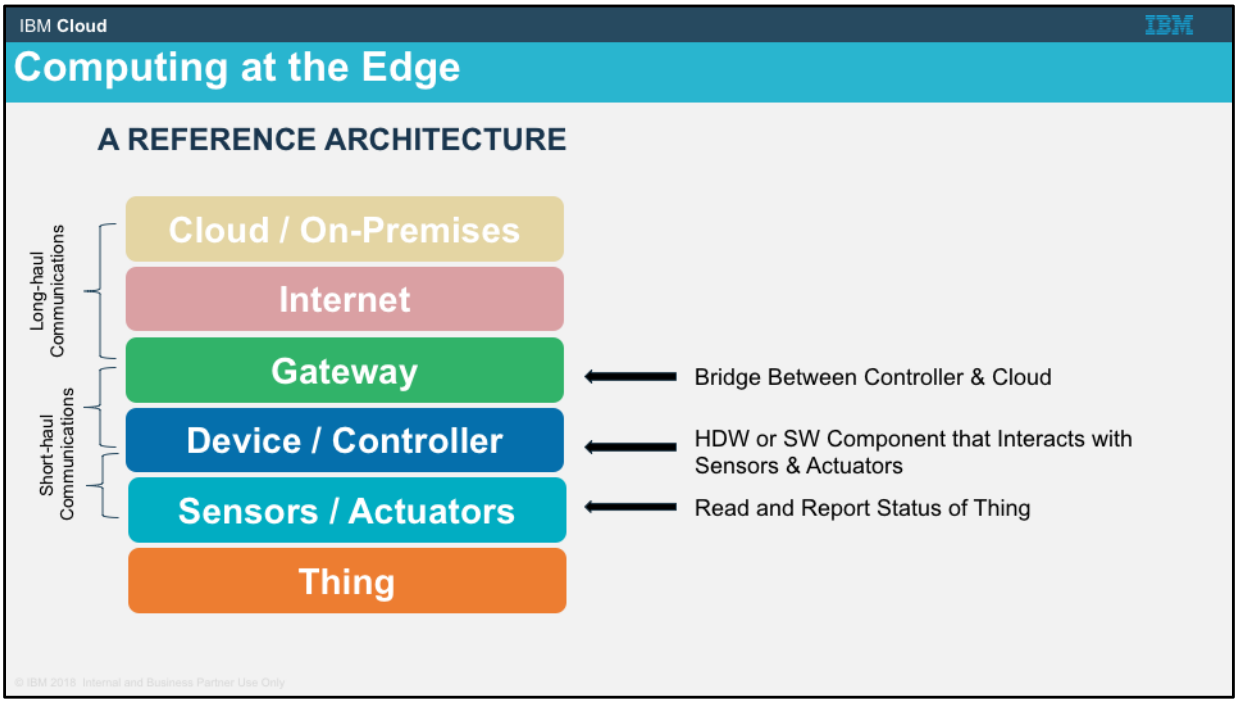
"**Edge**" refers to the computing infrastructure that exists close to the sources of data that typically resides away centralized computing.

Sensors - Reads and reports real-world status of connected products, machines and environments. Can be physical objects or product-specific output data. May be hardwired, built into a product, or communicate via short-haul comms like ZigBee or BLE

Actuators - Affect the electromechanical or logical state of a product or environment. They are the system's hands and feet. Light that can be turned on or off, or a value that can be opened and closed.

Devices - Hardware or software component that interacts with sensors and actuators. May be fused with other components of the stack. Can be as simple as circuit that reads an analog signal from a temp sensor and digitizes signal into a discrete transmissions that the upper layers of the stack can understand.

Gateways - Embedded program/device that runs near the IoT device and reports the status of an asset or environment.



https://www.oreilly.com/ideas/the-edge-of-the-iot

Sensors
Sensors read and report on the real-world status of connected products, machines, and local environments. They are the eyes and ears of the system, monitoring environmental elements like temperature, light, and moisture. Ongoing sensor innovation, an often-overlooked area of IoT technology, will be critical for evolving and improving solutions.

Actuators
Actuators affect the electromechanical or logical state of a product or environment. They are the system,Äôs hands and feet. Actuators might include a light that can be turned on and off, or a valve that can be opened and closed.

Controller
The next layer in our stack is the¬†*controller*, a hardware or software component that interacts electrically or logically with sensors and actuators. It is in the controller that we,Äôll find our low-level, short-haul communication.
While in many instances the controller may be fused within other elements of the

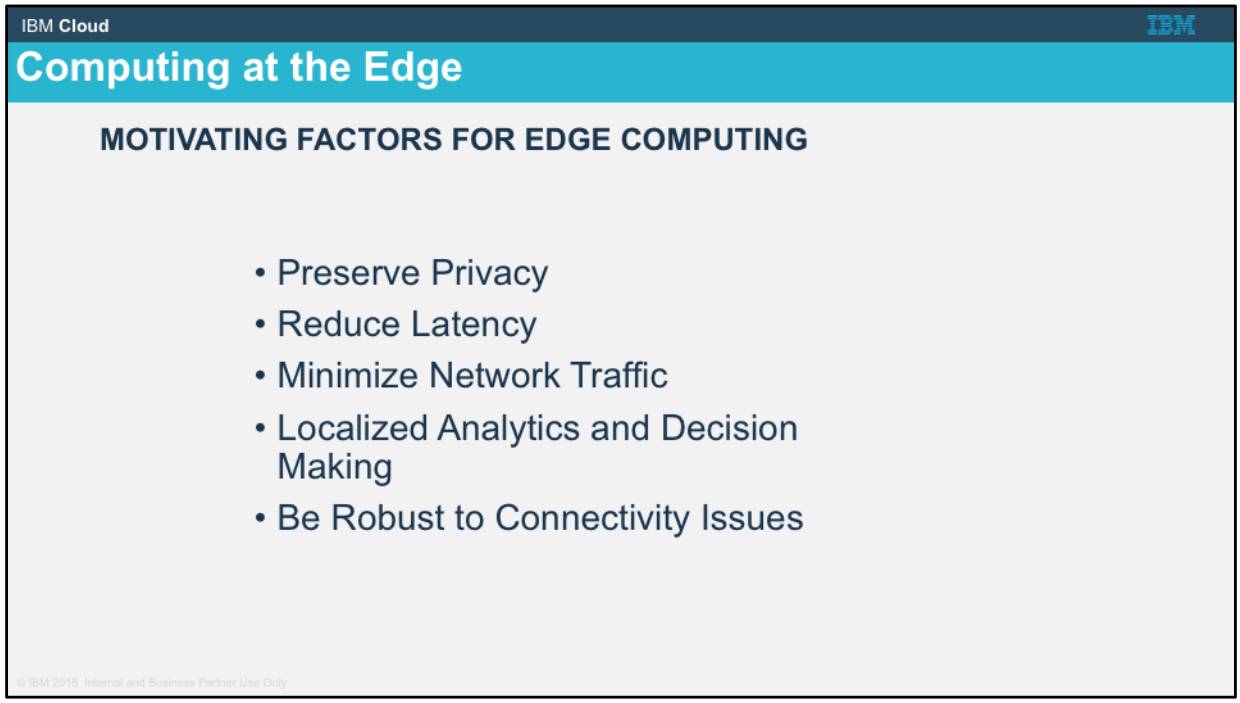
stack, it is always present logically. For example, a controller may be a simple circuit that reads an analog signal from a temperature sensor and digitizes the signal into discrete transmissions that the upper layers of the stack can understand.
Over short distances, local communication from sensors can come via a simple serial connection between devices, or short-haul wireless technologies like ZigBee.
Industries may define standard protocols for interfacing with equipment,Äîfor example, OBD-II for automobiles, or DEX and MDB for vending machines. All of these represent short-haul protocols, because they are meant for local communication between sensors, control systems, and an agent.

Gateway

The next layer in the stack is the¬†*agent*, an embedded program that runs on or near the IoT device and reports the status of an asset or environment. The agent acts as a bridge between the controller and the cloud, deciding what data to send and when to send it. This process operates in reverse as well, as the agent processes and responds to cloud-based commands and updates.
As an example of the controller and agent working in concert, imagine that we,Äôre engineering a proof-of-concept device for an IoT system using a Raspberry Pi and an Arduino with a breadboard. The Arduino is the¬†*controller*¬†running LEDs and servos, and acquiring data from a sensor. The Raspberry Pi is interfacing with the Arduino, and running a software¬†*agent*that decides when to send the sensor data to the cloud, via a long-haul connection to WiFi / Ethernet.

Long-haul communication

On the top layer of our architecture, we find our long-haul communication to the Internet. IoT solutions invariably require that environment or device status be made available to a cloud-based application for consumption by a variety of stakeholders. Once an agent has received information via short-haul, it must retransmit that information to the cloud. The desired characteristics of these long-haul protocols are much different than short-haul, particularly in the categories of security, footprint, and reliability. There are a wide variety of long-haul options for IoT solutions, dependent on the use case; they include cellular and satellite, WiFi and wired Ethernet, as well as subgigahertz options like LoRa and SigFox.
Networking protocols for long-haul communication are similarly diverse; they include TCP (Transmission Control Protocol) and UDP (User Datagram Protocol) for the transport layer, and HTTP (Hypertext Transfer Protocol) and CoAP (Constrained Application Protocol) for the application layer, among many others.



https://www.techopedia.com/2/32118/it-business/business-intelligence-bi/living-on-the-edge-the-5-key-benefits-of-edge-analytics

https://www.oreilly.com/ideas/the-edge-of-the-iot

Edge computing or *fog computing*—a paradigm championed by some of the biggest IoT technology players, including Cisco, IBM, and Dell—represents a shift in architecture in which intelligence is pushed from the cloud to the edge, localizing certain kinds of analysis and decision-making. Edge computing enables quicker response times, unencumbered by network latency, as well as reduced traffic, selectively relaying the appropriate data to the cloud.

Regardless of whether system intelligence is ultimately located in the cloud or the fog or some hybrid of the two, development for the Internet of Things requires technologists to have a clear understanding of edge architecture and how information is both gathered from devices and communicated.

https://www.ibm.com/blogs/internet-of-things/edge-iot-analytics/

1. Preserve privacy

Data captured by IoT devices can contain sensitive or private information, e.g., GPS data, streams from cameras, or microphones. While an application might want to use this information to run complex analytics in the Cloud, it is important that, whenever data leaves the premises where it is generated, the privacy of sensitive content is preserved. With Edge Computing, an application can make sure that sensitive data is pre-processed on-site, and only data that is privacy compliant is sent to the Cloud for further analysis, after having passed through a first layer of anonymizing aggregation.

2. Reduce latency

The power and flexibility of Cloud computing has enabled many scenarios that were impossible before. Think about how the accuracy of image or voice recognition algorithms has improved in recent years. However, this accuracy has a price: the time needed to get an image or a piece of audio recognized is significantly affected by the non-negligible yet unavoidable network delays due to data being shipped to the Cloud and results computed and sent back to the edge. When low-latency results are needed, Edge Computing applications can implement machine-learning algorithms that run directly on IoT devices, and only interact with the Cloud off the critical path, for example, to continuously train machine learning models using captured data.

3. Be robust to connectivity issues

Designing applications to run part of the computation directly on the Edge not only reduces latency, but potentially ensures that applications are not disrupted in case of limited or intermittent network connectivity. This can be very useful when applications are deployed on remote locations where network coverage is poor or even to reduce costs coming from expensive connectivity technologies like cellular technologies.

Technology

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Technology

SENSORS

- Humidity
- Light
- Water Quality
- Chemical
- Smoke
- IR
- Level
- Image
- Motion
- Accelerometer
- Gyroscope
- Optical

TEXAS INSTRUMENTS

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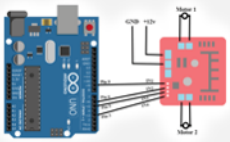
Technology

ACTUATORS

- Lights
- Valves
- Motors



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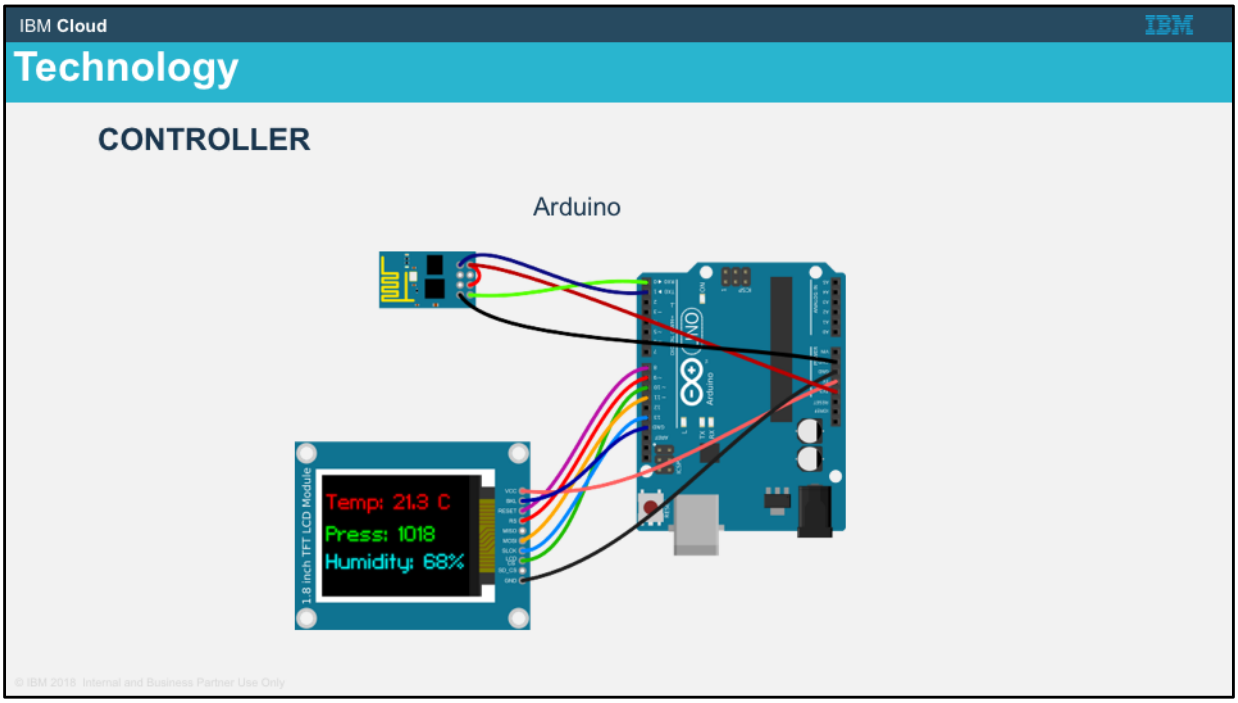

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Technology

GATEWAYS

- Raspberry PI
- Platform

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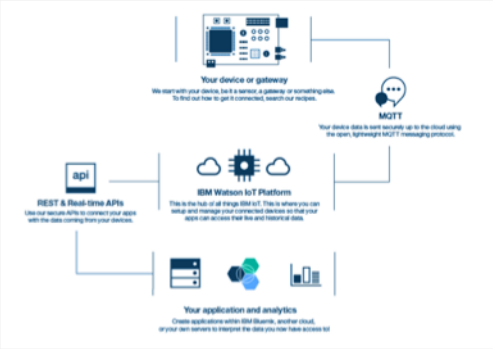
Technology

IOT PROTOCOLS

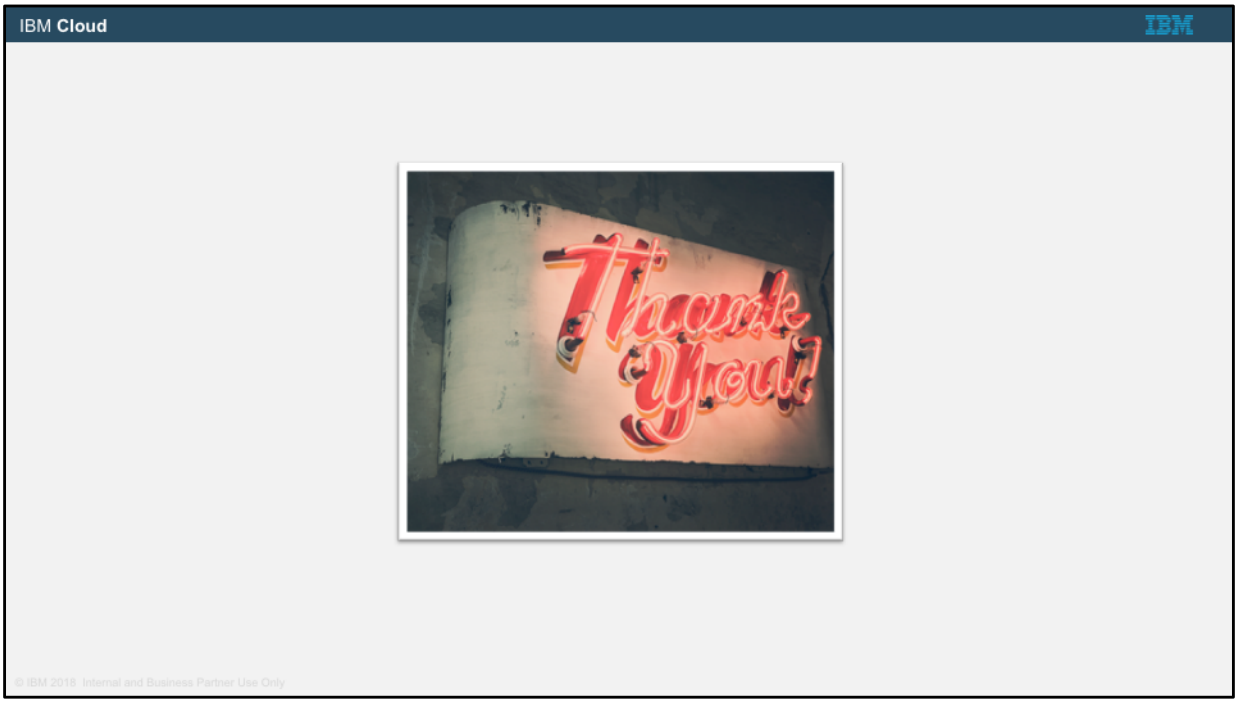
- **Bluetooth Low Energy (BLE)**
  - Similar to Bluetooth but designed for significantly reduced power consumption.
- **Zigbee**
  - Used mostly in industrial settings. High security for M2M and IoT applications.
- **Z-Wave**
  - Low power RF communications technology used primarily in home automation products.
- **Cellular**
  - Good for low bandwidth data, especially due to cost.

Technology

WATSON IOT PLATFORM



- Tight Integration with IBM Cloud
- Simplified IoT Data Management
- Platform for IoT Analytics, Development & Deployment
- Rich Library of IoT Samples



Thank you and have a great day!