2. Sensors and devices

Introduction

A sensor is a module that is sensitive to changes in its environment and sends information to a device about those changes.

Devices collect sensor data and forward it to the cloud. Devices can be quite small, and have very few computing, storage, and so on resources. They could only communicate via networks that can not directly access a cloud server, such as over Bluetooth Low Energy (BLE). Conventional devices are more likely to look like small machines, and may be able to store, process, and analyze data before it is sent to the cloud.

Sensors types

There are several types of IoT sensors, and many more applications and use scenarios. Here are some of the IoT sensor types that are most common and some of their use cases.

- *Temperature Sensors.*
- *Humidity Sensors.*
- *Pressure Sensors.*
- *Proximity Sensors.*
- *Level Sensors.*
- *Accelerometers.*
- *Gyroscope.*
- *Gas Sensors.*
- *Optical Sensors*

Sensors can be divided by their external power requirements:

Choosing a Sensor

There are several factors to consider when choosing an IoT sensor. The target of an IoT sensor and computer is usually long life with little human interaction. You expect IoT sensors and devices to be put in the desired area, and have them operate for an extended time. They could be in a remote area, or deeply embedded in a structure, inaccessible to humans. In this case, replacing a sensor and system can be incredibly costly, risky, or even impossible; all reasons to carefully consider your decisions about sensors and devices.

One‘s decision is based on a lot of factors. When designing your system, care must be taken to consider the importance of each factor and its priority over the overall design.

The following list of requirements can be viewed as a starting point for any discussion of the IoT sensors.

Longevity

Durability in relation to the sensor environment must be considered. You want to ensure that your computer is as robust as it needs to function for a reasonable period of time, without incurring unnecessary costs.

For example, a water-resistant temperature sensor may be suitable to a remote weather station, but it would be completely inappropriate for monitoring water temperature in a pool, as it is not waterproof.

Accuracy

You want adequate precision to track an area correctly but you don't want to spend more than you need.

For instance, if you are constructing a device to control the temperature in a remote household storage unit, you are likely willing to accept a sensor with + /- 2 degrees of accuracy. If you designed a medical device program, the accuracy would be absolutely unacceptable. A temperature sensor for medical devices will need to be sensitive to + /- 0.2 degrees!

Versatility

The sensors must be capable of operating within acceptable environmental variations. Since most IoT network designs often have sensors, it is important to have sensors that can operate accurately in all environmental variations in a variety of environments.

For instance, if you are building remote weather stations of wilderness areas, you'll need sensors that can handle severe summer and winter temperatures. Sensors which only operate accurately at room temperature would not be practical.

Power consumption

Your specifications could be for a low-power, or even very low-power system, depending on the situation. You'll need to decide if power-saving features (such as sleep mode or quick wake-up) are needed.

A sensor or device powered by solar-charged batteries, for example, may need to spend a large part of its life in sleep mode to extend battery life during low-light times. It can need fast wake-up times to collect data accurately, too.

Additional considerations affecting the climate

The choice of sensors can also influence the final design of the system.

For example, when developing a water quality monitoring system, a sensor that can be installed inside the main water supply piping is far more suitable, more cost-efficient and accurate than a sensor requiring water samples to be diverted.

Cost

IoT networks typically include hundreds of sensors and computers, or even thousands. From a cost perspective, every aspect of sensor design needs to be evaluated. Those costs are more than just the sensor 's price. The cost of the location, repair, reliability, etc. must be weighed.

Devices

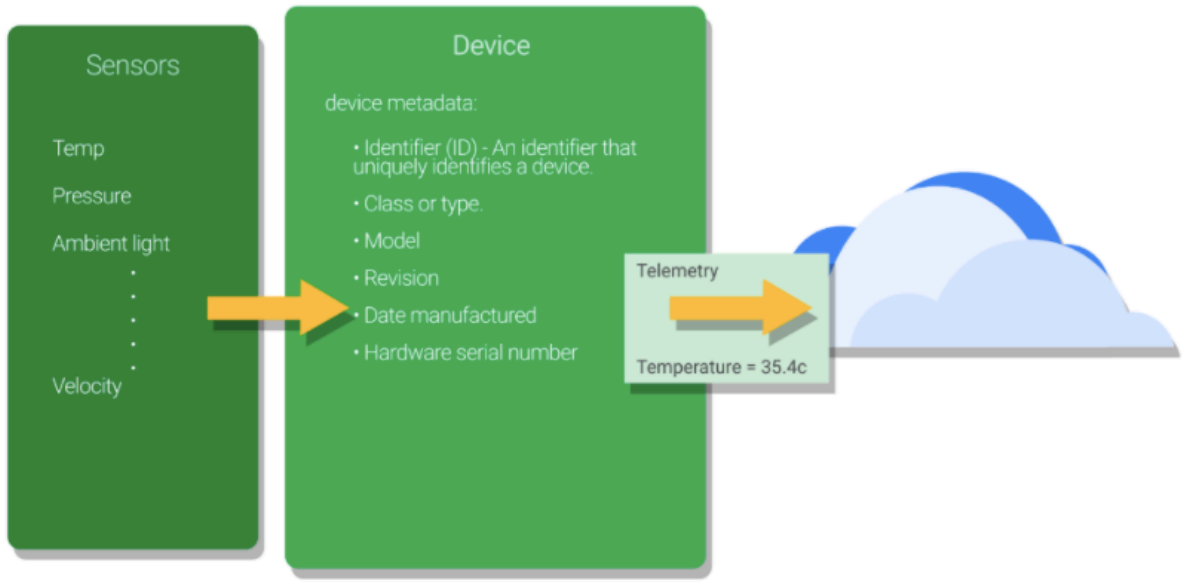


Figure 1. Sensors and Devices (source: Google Cloud)

A "Thing" in the "Internet of Things" is a processing device that can connect to the web and share data with the cloud. Devices are also referred to as "smart devices" or "connected devices," that communicate two data types: telemetry & state.

Information Types:

Each device can supply or consume information of various types. Each form of information could best be managed by a different backend system, and the data rate, volume, and preferred API should be specialized in each system.

Metadata on devices

Metadata contains device details. Most of the metadata changes rarely if ever. Examples of fields for the metadata include:

1. Identifier (ID) - An identifier that uniquely identifies a device.
2. Class or type
3. Model
4. Revision
5. Date manufactured
6. Hardware serial number

Telemetry

The data that the device collects is called telemetry. These are the eyes-and-ears data IoT devices offer applications with. Telemetry is environment data that is read-only, usually collected through sensors.

State information

State information defines the device's current status, not the environment. They can read/write this information. It's updated, but usually not often.

Device Commands

Commands are actions a device performs.

Commands may be valid for a short period so a time-to-live (TTL) or another expiration date should be included.

Examples of these commands are:

- A 360-degree rotation to the right.
- Managed process of self-cleaning.
- Raising the rate by 10 percent.

Operational information

Operational information is data most relevant to the device's operation, as compared to the business application. It may include issues like the working temperature of the CPU and the state of the battery. This type of data does not have long-term analytical value, but it has a short-term value to help sustain the state of operation, such as reacting to breakages and fixing device performance degradation after upgrades.

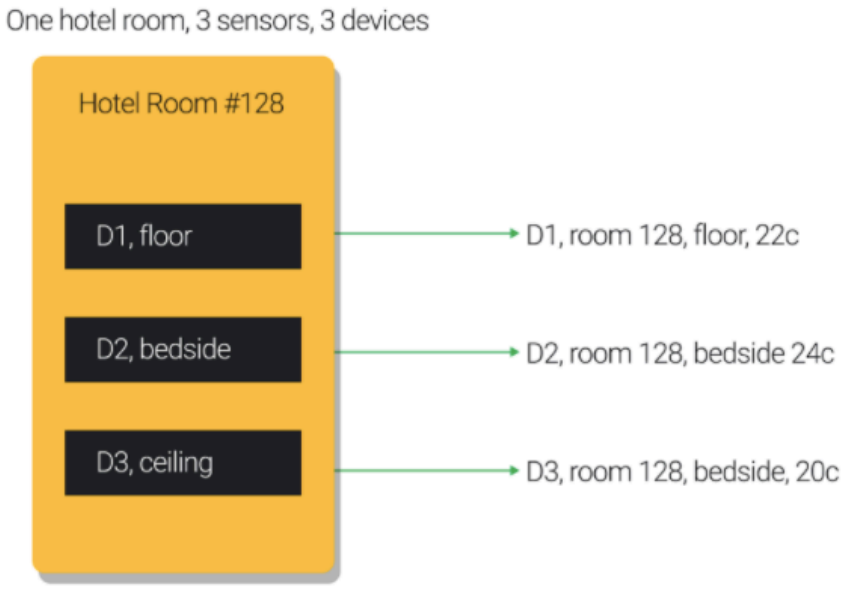
The operational information may be transmitted as state or telemetry data.

Defining Devices

In IoT, device definition can change depending on project needs. When you plan your project you want to think about degrees of abstraction. There may be times when you would like to see each device as a separate entity, and other times when you want to see a group of sensors as a single unit for reporting.

The application 's precise specifications will help you understand how anything that produces information should be regarded as a computer, and therefore deserves its own ID, or is merely a channel or state description of another system.

Consider, for instance, a project to track the temperature in hotel rooms. -- the room is fitted with three sensors: near the floor, near the bed, and near the ceiling.



With this design, data is sent as three separate devices to the cloud, each transmitting information on temperatures to the cloud.

{deviceID: "dh28dslkja", "location": "floor", "room": 128, "temp": 22 }

{deviceID: "8d3kiuhs8a", "location": "ceiling", "room": 128, "temp": 24 }

{deviceID: "kd8s8hh3o", "location": "bedside", "room": 128, "temp": 23 }

Google IoT Developer Prototyping Kits

Google is working with partners to build app starter kits that make it easy for developers to connect to Google Cloud IoT Platform. Google has collaborated with 14 companies at this time to provide a wide range of prototyping kits for IoT developers.

Developers use kits for fast project prototyping. Kits can be selected for their system processor, sensors, capacity to extend, etc. An IoT developer needs to review each of the kits before choosing a kit to decide the one that would be the best match for the desired project. For instance, if a project needs a low-cost board, the developer may choose to use the Mongoose TI starter kit or the Sierra wireless kit to investigate.

References

Google Cloud LLC, 2020. *Google Cloud.* [Online]
Available at: https://cloud.google.com
[Accessed 2020].

Statista, 2020. *Internet of Things (IoT) active device connections installed base worldwide from 2015 to 2025*.* [Online]
Available at: https://www.statista.com/statistics/1101442/iot-number-of-connected-devices-worldwide/
[Accessed 2020].