CT106-3-M-BIA - Building IoT Applications

CT127-3-M-ODL - BIA - Building IoT Applications

Topic 1 - Introduction to the Internet of Things (IoT)

TOPIC LEARNING OUTCOMES

At the end of this topic, you should be able to:

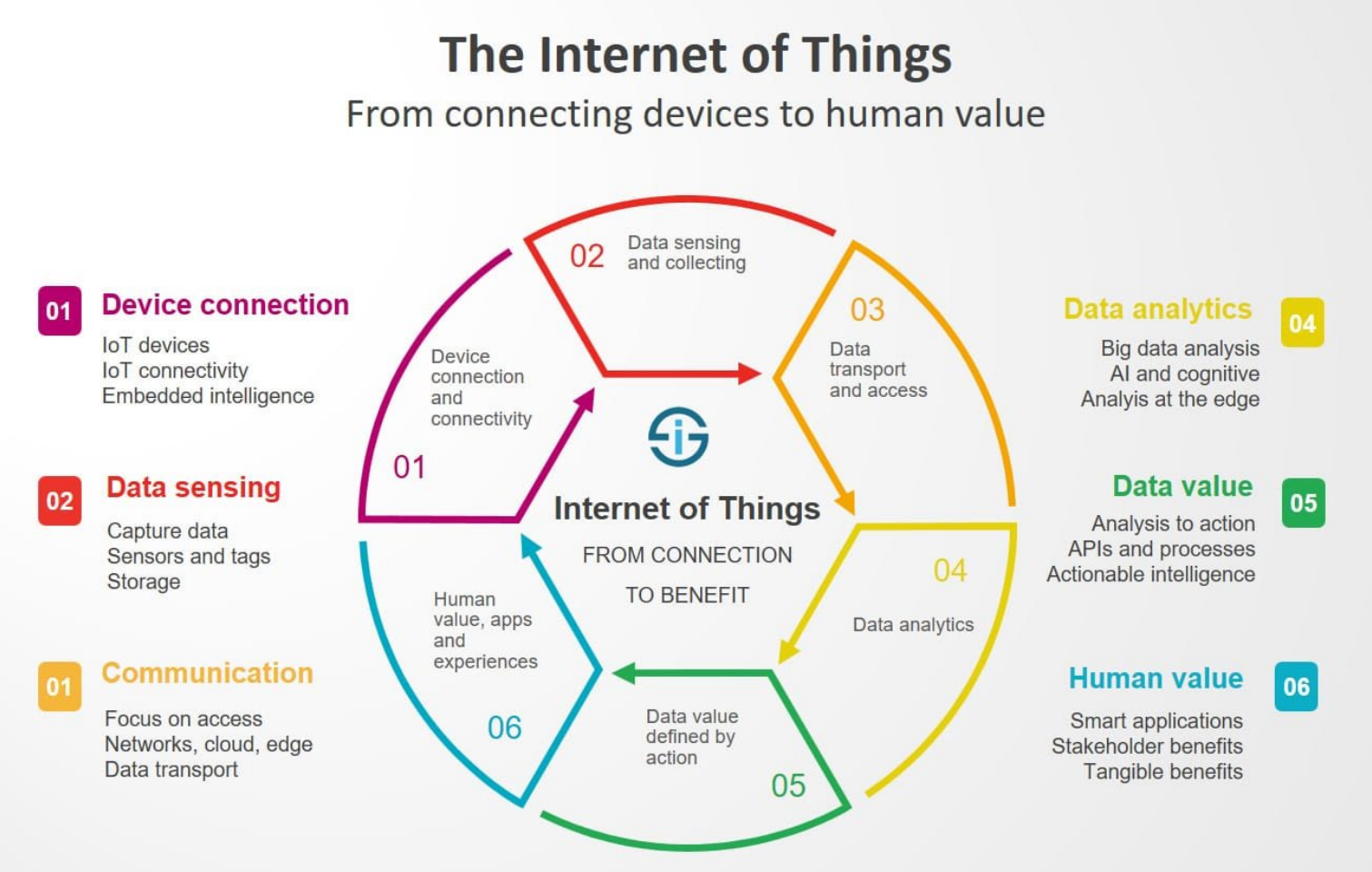
- Define IoT and explain its concept, emphasizing the network of interconnected physical objects and their ability to collect and exchange data over the Internet.
- Understand the origins and evolution of IoT, including its early beginnings and the factors that contributed to its growth and widespread adoption.
- Identify and describe the key components of IoT hardware, such as sensors, actuators, microcontrollers and microprocessors.
- Explore prototyping tools used in IoT development that facilitate the creation of IoT prototypes and proofs-of-concept.
- Explore data acquisition, analysis and visualization tools used to collect, analyze, represent and interpret IoT data, including graphical interfaces and dashboards.

Contents & Structure

- What is IoT?
- How did it start?
- IoT Hardware:
  - Sensors and Actuators
  - Microcontrollers and Microprocessors
- IoT Software:
  - Prototyping Tools
  - Professional Programming IDEs
  - Data Acquisition and Analysis Software
  - Visualisation Tools

What is Internet of Things?

The Internet of Things (IoT) refers to a network of interconnected physical devices, vehicles, appliances, and other objects embedded with sensors, software, and network connectivity that enables them to collect and exchange data.



Source: https://inventrom.wordpress.com/2014/11/27/the-thing-in-interne t-of-things/

What is the Internet of Things (IoT)

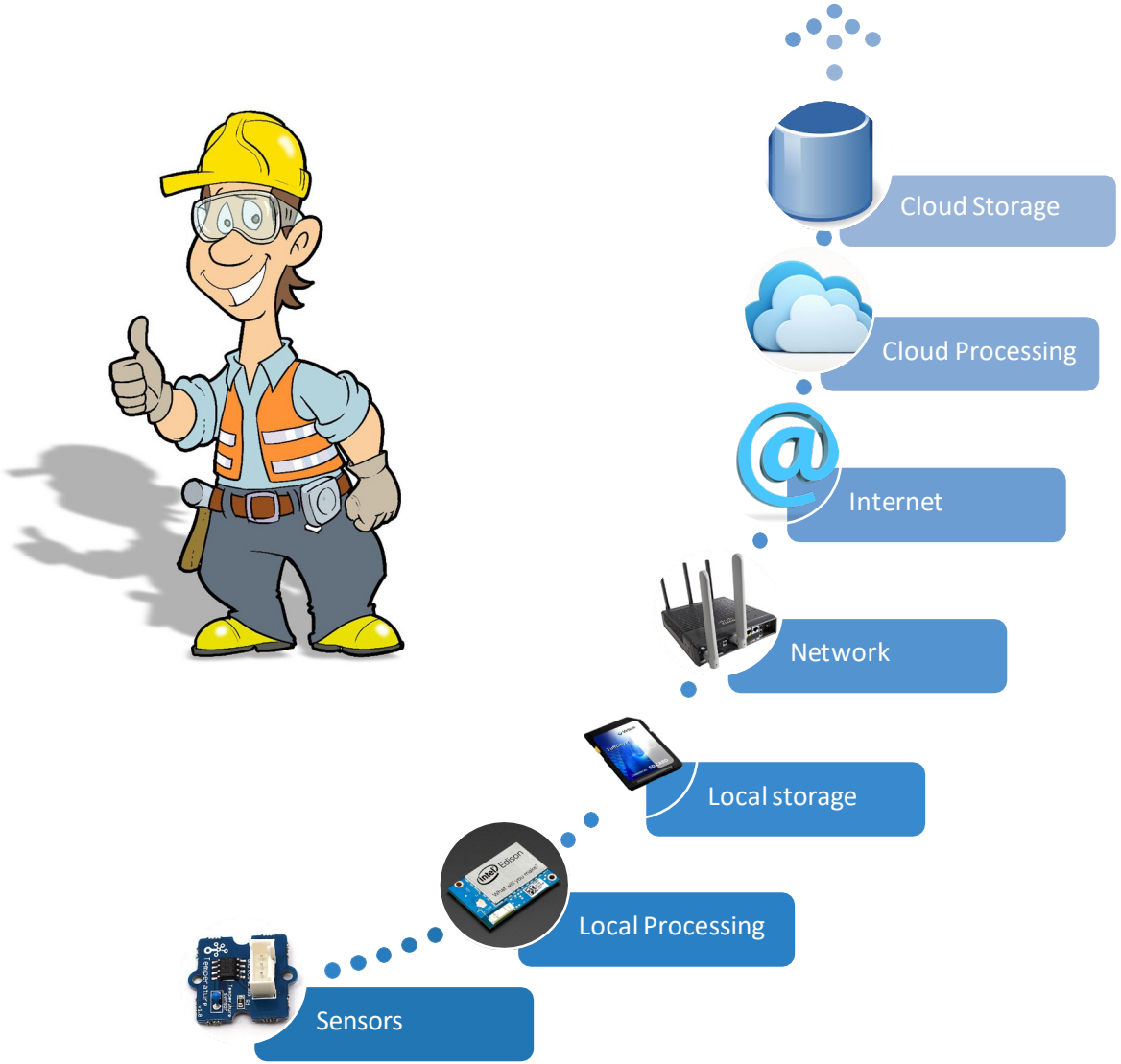


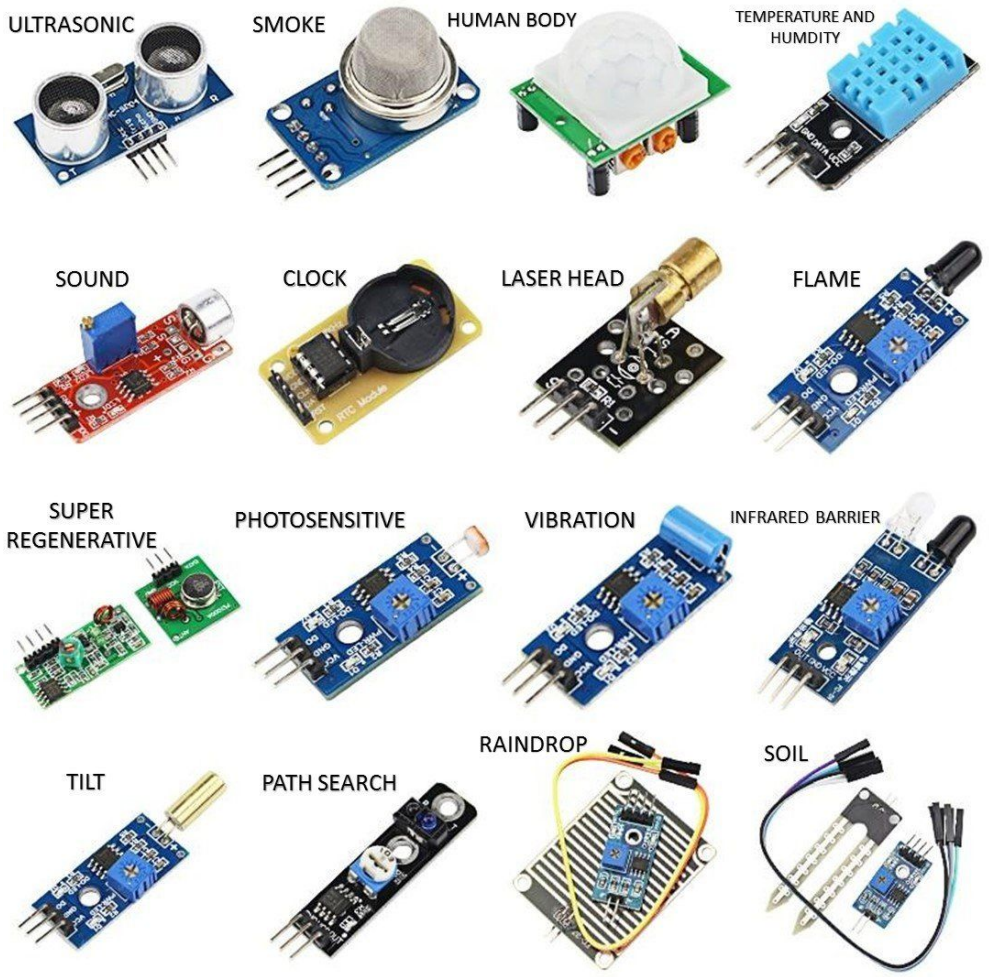
Image from http://www.cchc.cl/informacion-a-la-comunidad/industria-de-la-construccion/personaje/

Sensors

Measure values

Send raw data

Low power



Local Processing and Local Storage

Get data from sensors

Process

Send some data to

Edge/Fog Computing

Network and Internet

IoT Gateway

Gathers data from sensors

Gateway Protocols

- 6LoPAN
- LoRaWAN
- BLE

Internet Protocols

- CoAP
- MQTT
- HTTP
- XMPP

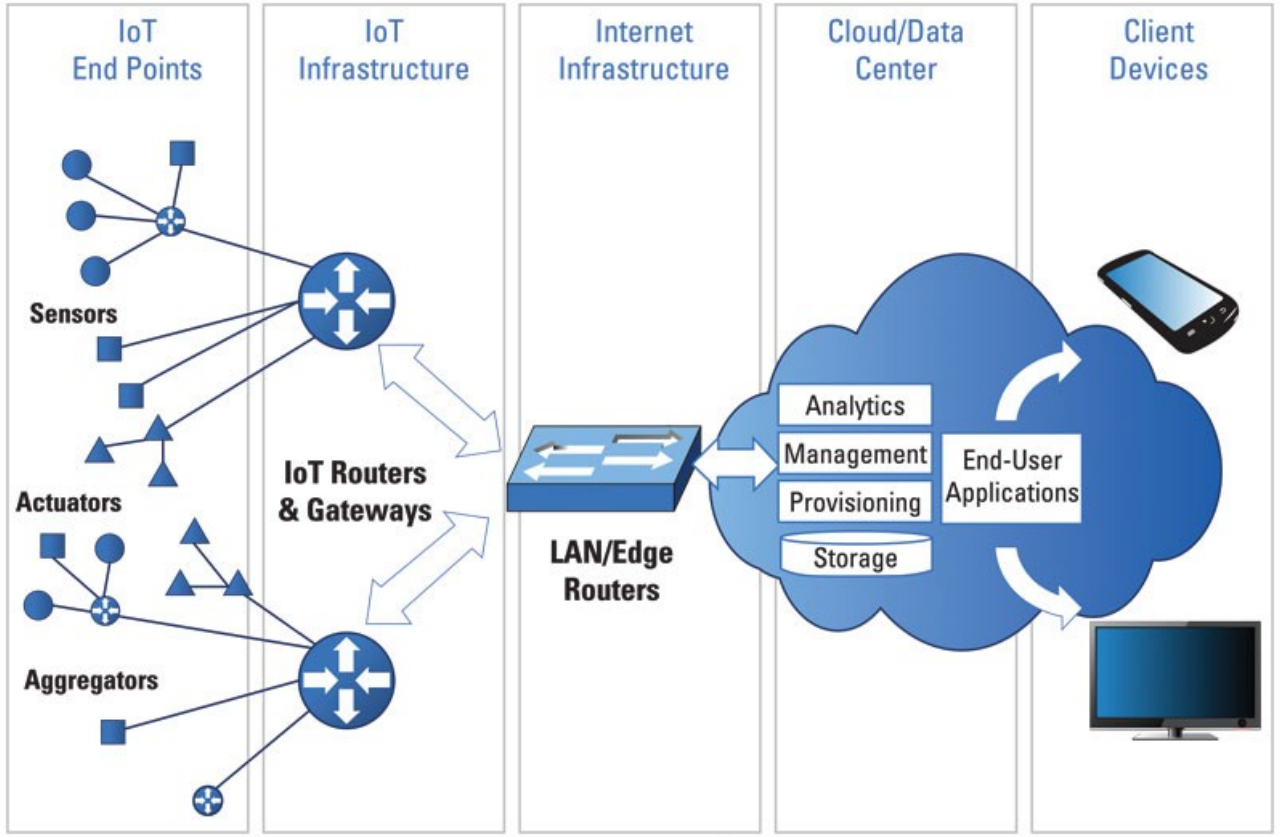
Cloud Processing and Storage

Aggregate Data

Storage

Inferences

IoT Network



http://www.rtcmagazine.com/articles/view/105734

How did it start

open source hardware

Origins of the Internet of Things (IoT)

- **Embedded Systems:** The concept of embedding computing capabilities into physical objects can be traced back to the 1970s with the emergence of embedded systems. These systems were designed to control and monitor specific functions in various devices and machines.
- **Machine-to-Machine (M2M) Communication:** In the 1980s, the idea of machines communicating with each other without human intervention gained traction. M2M communication aimed to enable devices to share data and work collaboratively in industrial settings.
- **Internet of Things (IoT):** The term "Internet of Things" was coined in the late 1990s but the evolution of IoT gained momentum with advancements in technology. The proliferation of wireless networks, the miniaturization of sensors, and the development of low-power microcontrollers played pivotal roles.

Concepts close to IoT

Ambient Intelligence (AmI):

- AmI leverages IoT technologies, sensors, and artificial intelligence to create smart environments that anticipate and respond to human behaviour.
- It refers to a vision where technology seamlessly integrates into our surroundings, creating intelligent and responsive environments.

Ubiquitous Computing

- Ubiquitous Computing (or pervasive computing) involves the idea of having numerous interconnected devices and sensors embedded in our environment, allowing for ubiquitous access to computing resources and services.
- It emphasizes the integration of computing technology into everyday objects and surroundings to enable seamless interactions and information access.

Why is this happening now?

Affordable hardware

- Costs for actuators & sensors have been cut into half over the last ten years.

Ubiquitous & cheap mobility

- Cost for mobile devices, bandwidth and data processing have declined as much as 97% over the last ten years.

Availability of supporting tools

- Big data tools & cloud-based infrastructure have become widely available and fairly sophisticated.

Why is this happening now?

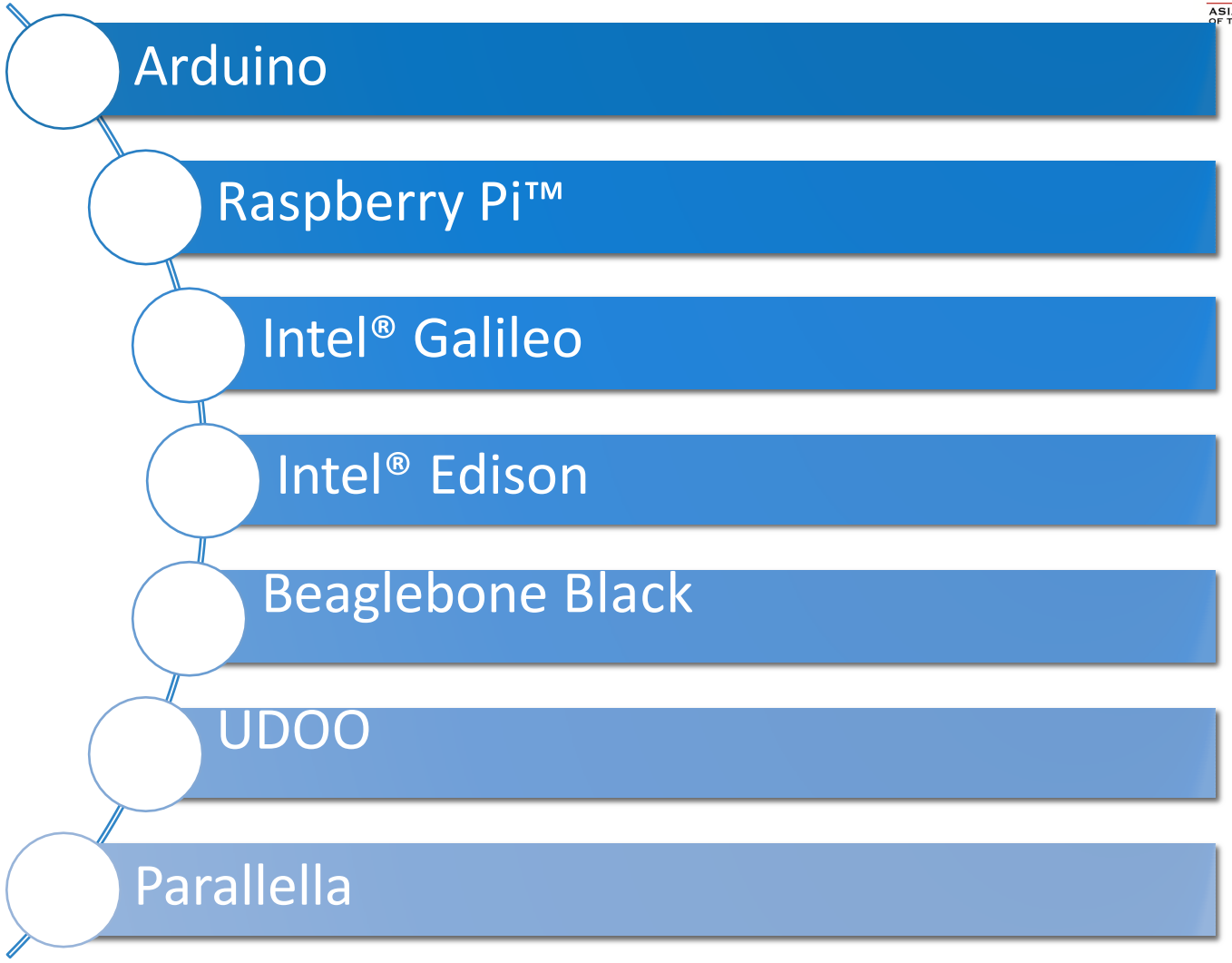
Smaller, but more powerful hardware

- Form factors of hardware (sensors, communication technology, etc.) have shrunk to millimeter or even nanometer levels. Now you can get a low-energy, state-of-the-art sensor with ubiquitous connectivity the size of your fingertip.

Mass market awareness

- The vision of a connected world has reached such a followership that companies have initiated IoT development & marketing budgets.

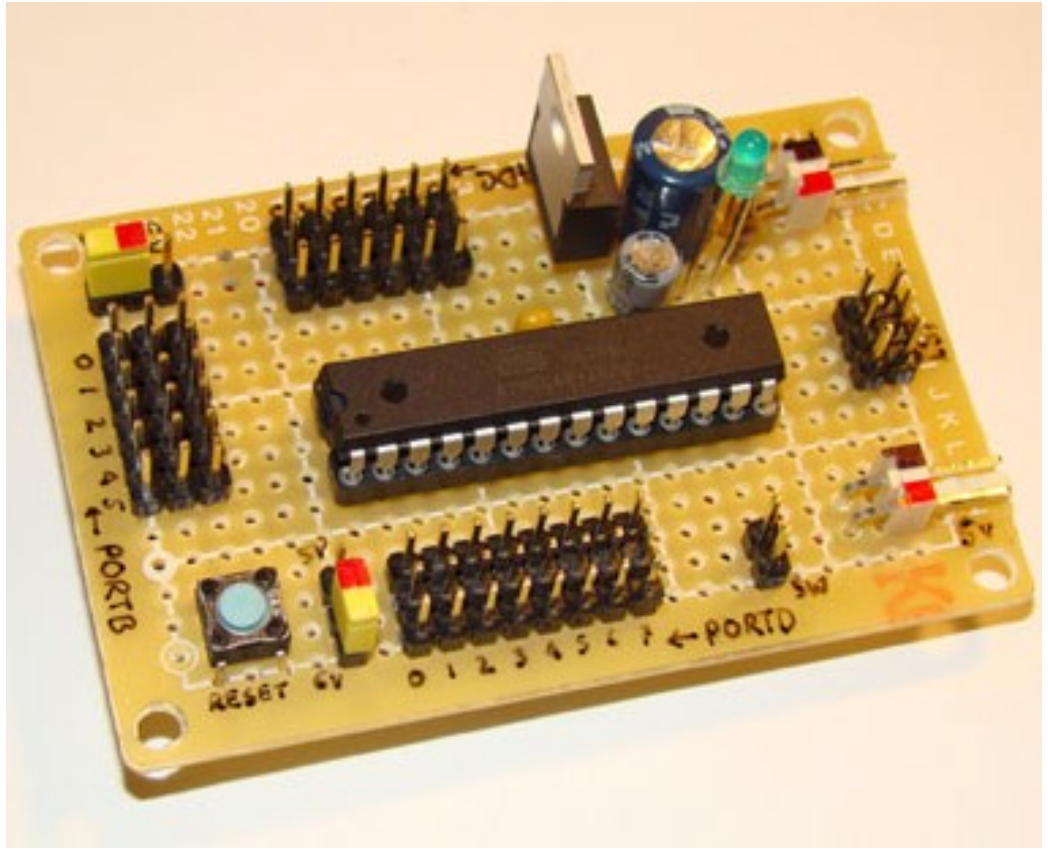
IoT Hardware



Microcontroller

Small programmable device

Easy connectable



Arduino

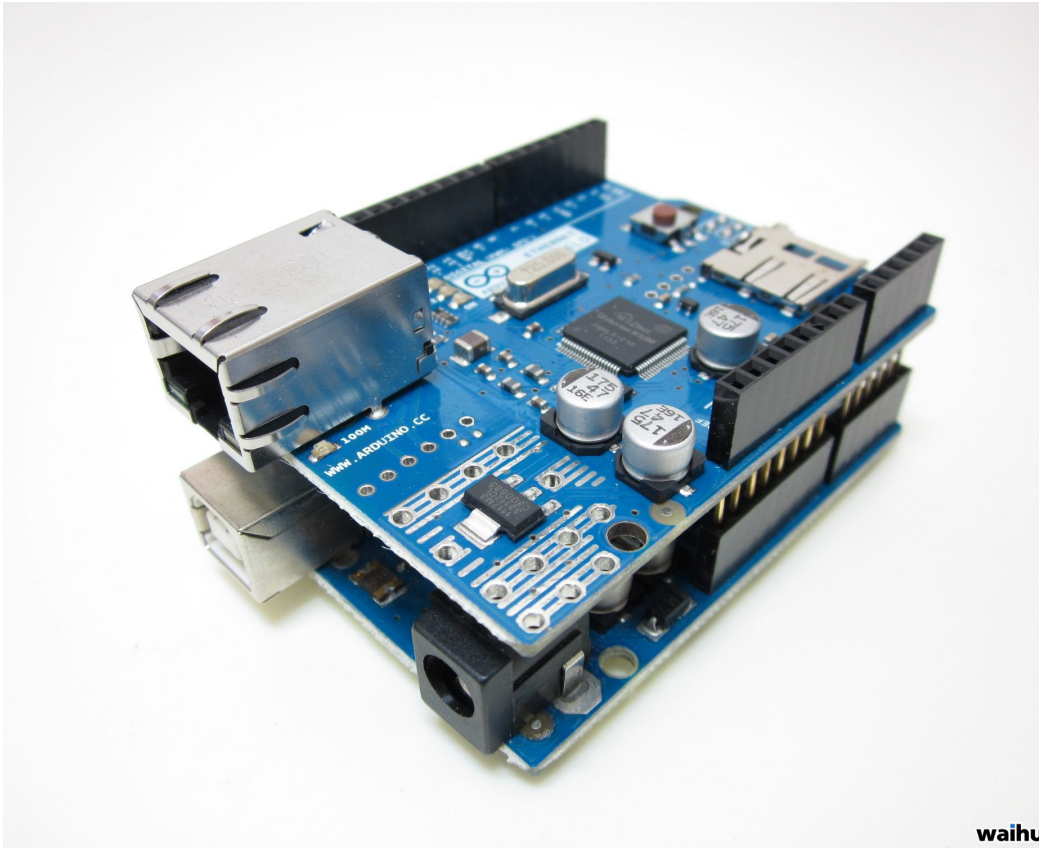
Small programmable device Easy

connectable

Is open source

Has a simple to use software

Only around 4 simultaneous networking connections



Microprocessor

High processing power and memory

Higher power consumption

Expensive

Raspberry Pi

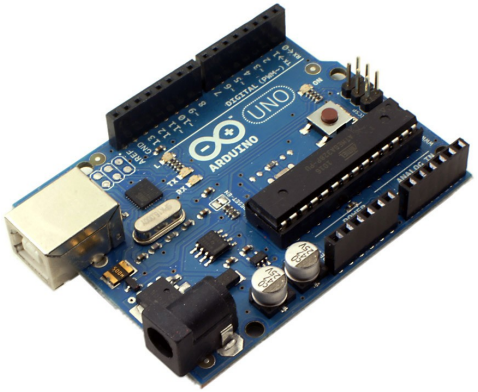
Computer

Runs Linux OS called Rasbean

More software-oriented programming

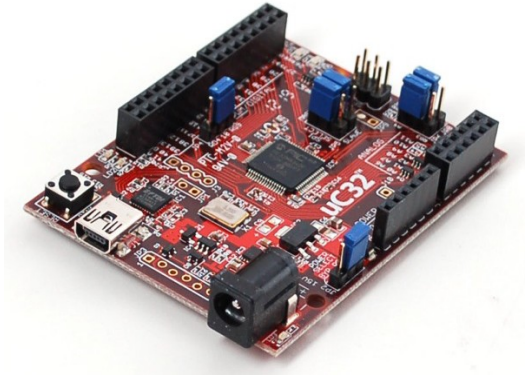
Full Networking System

Good for sensors



Arduino
ATmega328

ChipKIT
PIC

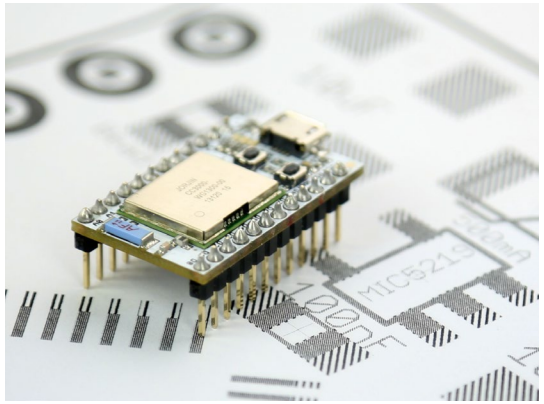


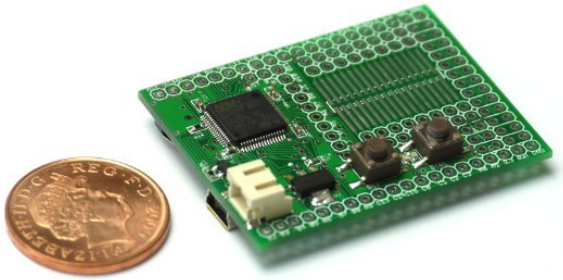
LaunchPad
MSP430

Good for some sensors and processing

STM32
ARM Cortex M0,
M3, M4

Particle
ARM
WiFi Internet



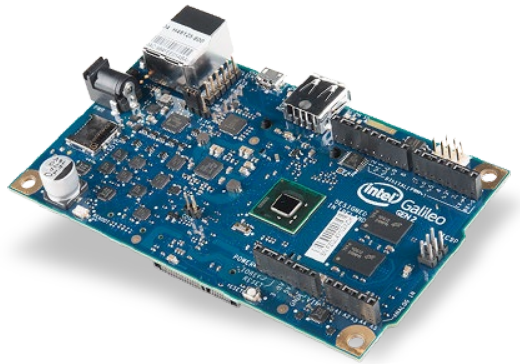


Espruino
ARM
Javascript

Good for processing and network

Raspberry Pi
900 MHz ARM, GPU
1 GB RAM
Compute Module

Intel® Galileo
400 MHz Quark x86
256 MB RAM

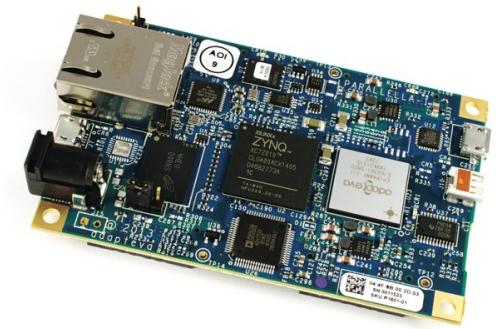


Intel® Edison
1 GHz Dual Core Atom x86
1 GB RAM
WiFi
BLE
4 GB Flash

Good for processing and network

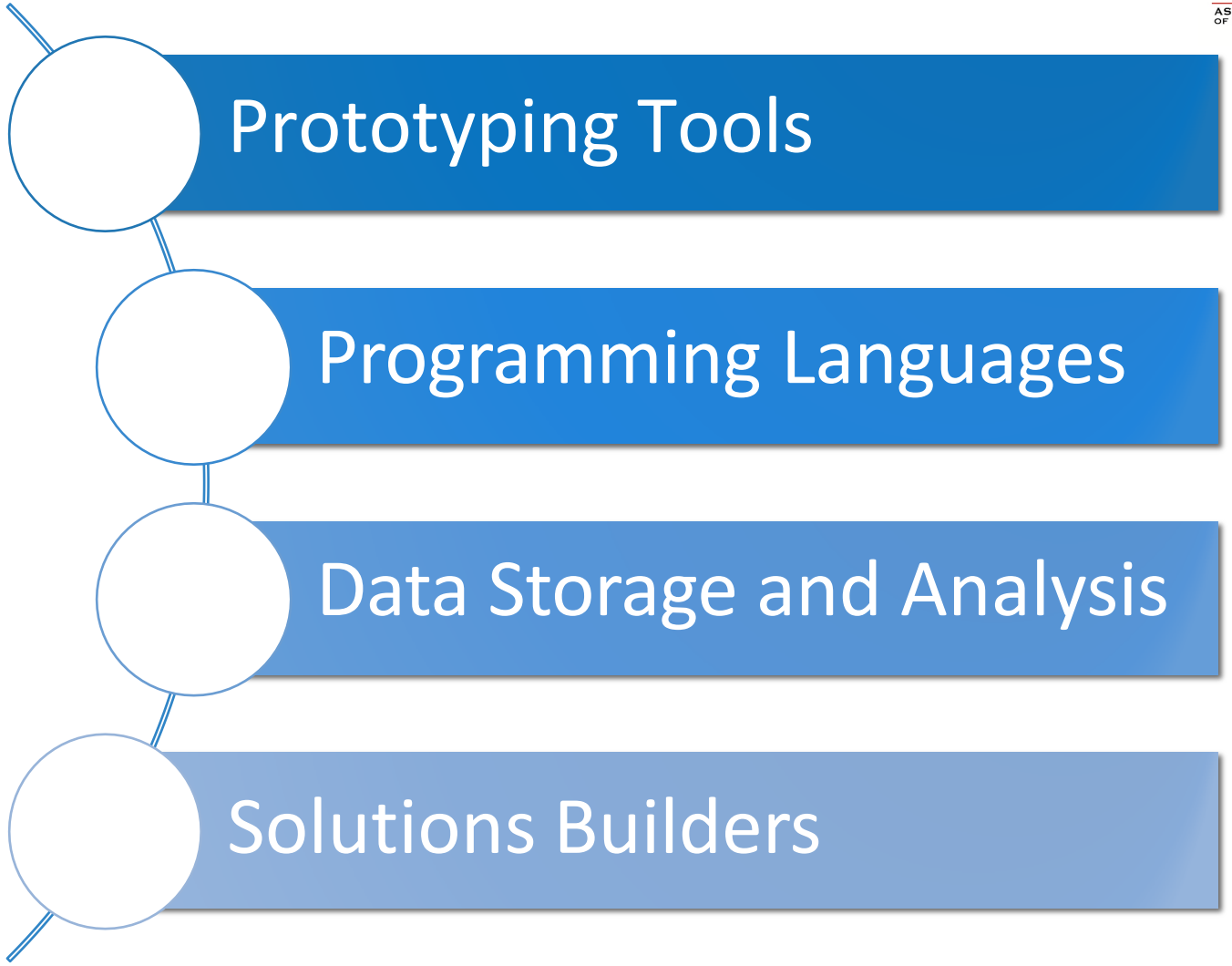
Beaglebone Black
1 GHz ARM, GPU
512 MB RAM
4 GB Flash

UDOO Neo
i.MX 6 Solo ARM, GPU
ARM M4
512 MB or 1 GB RAM



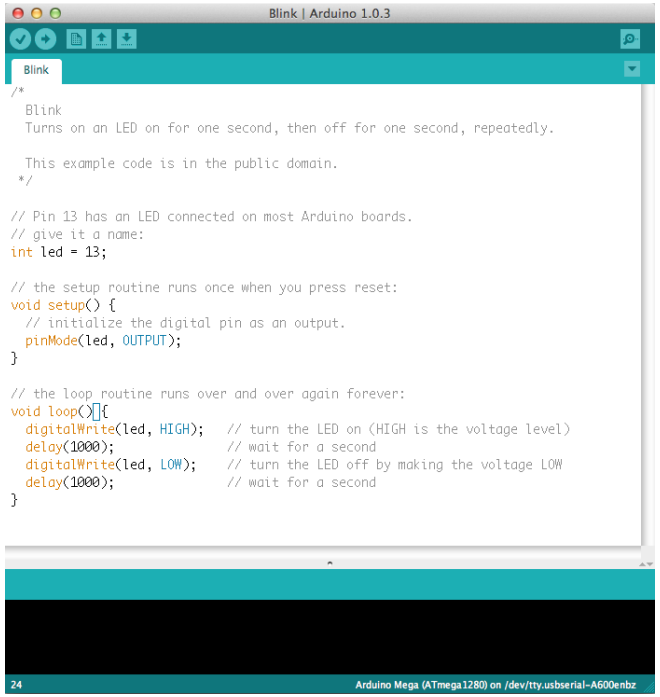
Parallella
1 GHz Dual Core Zynq ARM
16 or 64 Epiphany CPUs

IoT Software

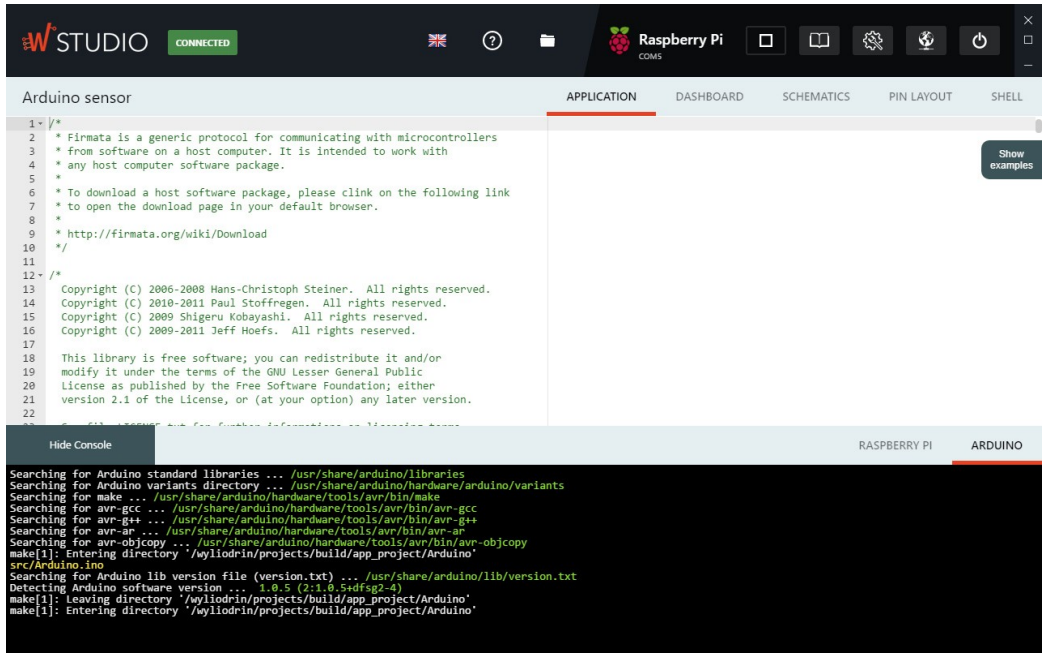


Prototyping

ARDUINO

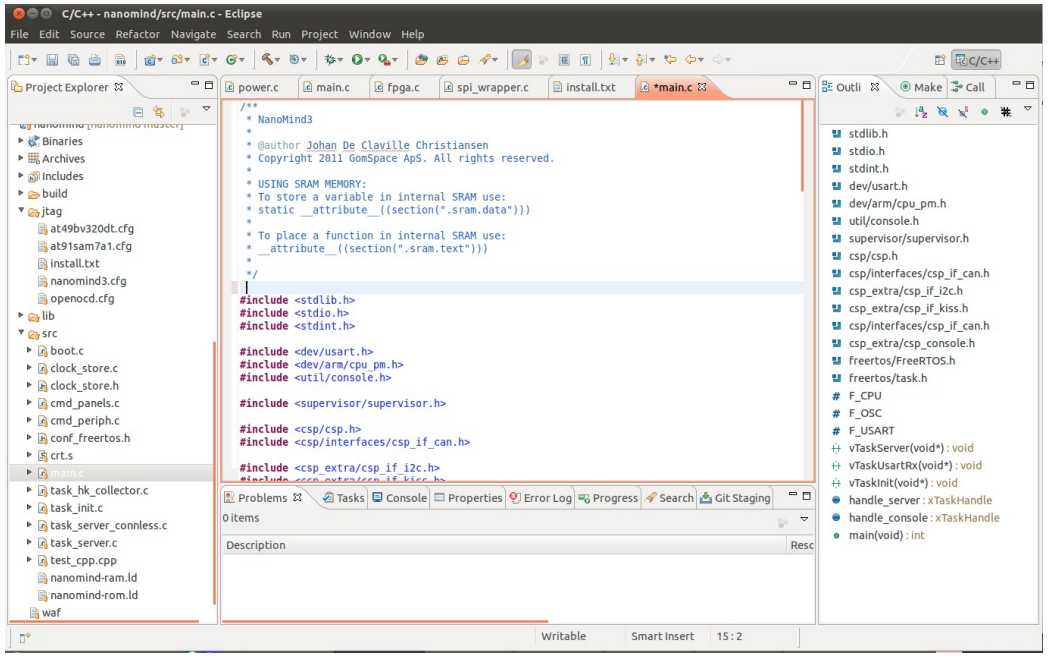


WYLIODRIN STUDIO

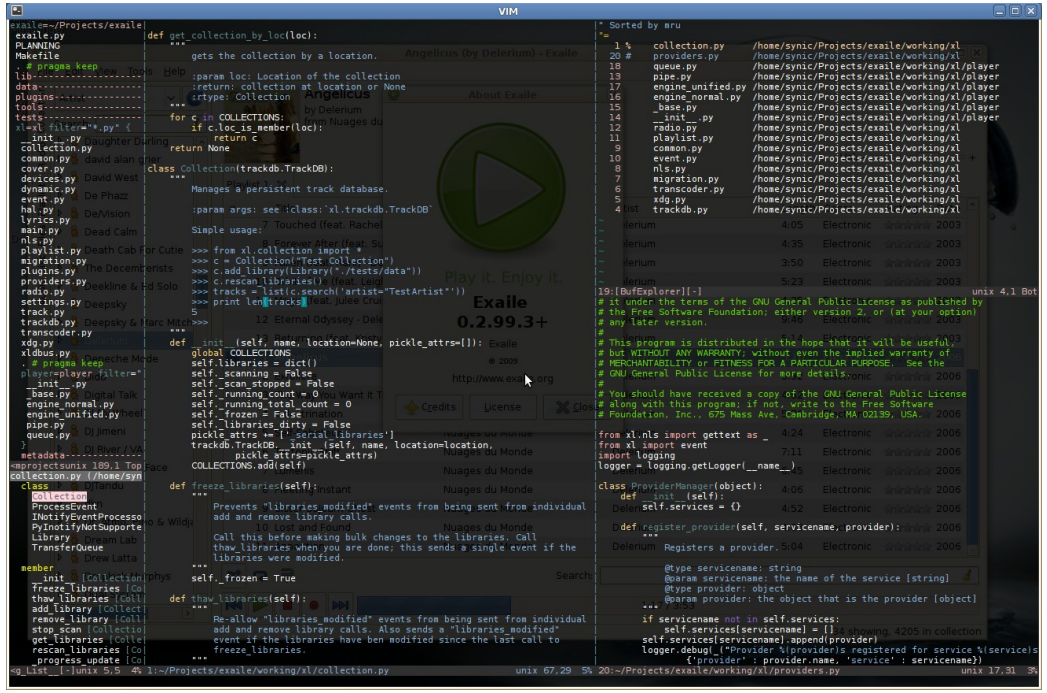


Professional Programming IDEs

ECLIPSE

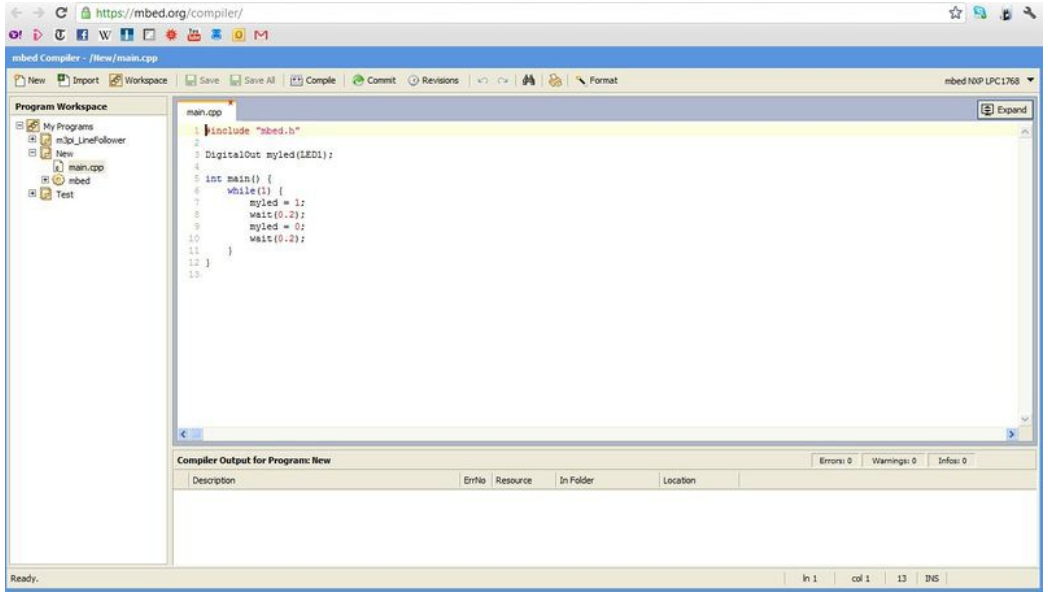


VIM

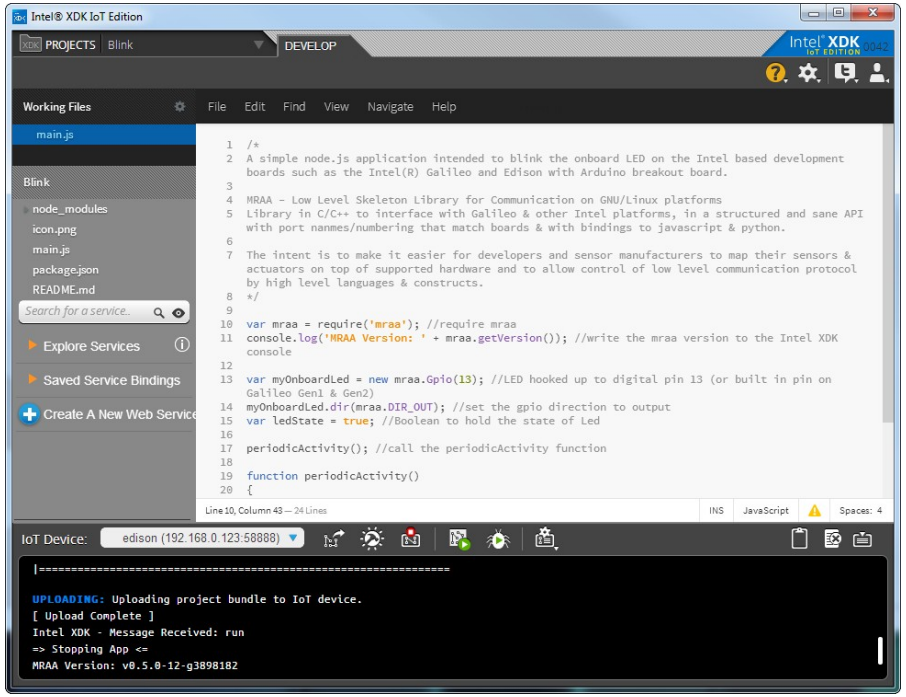


Professional Programming IDEs

MBED (ONLINE)

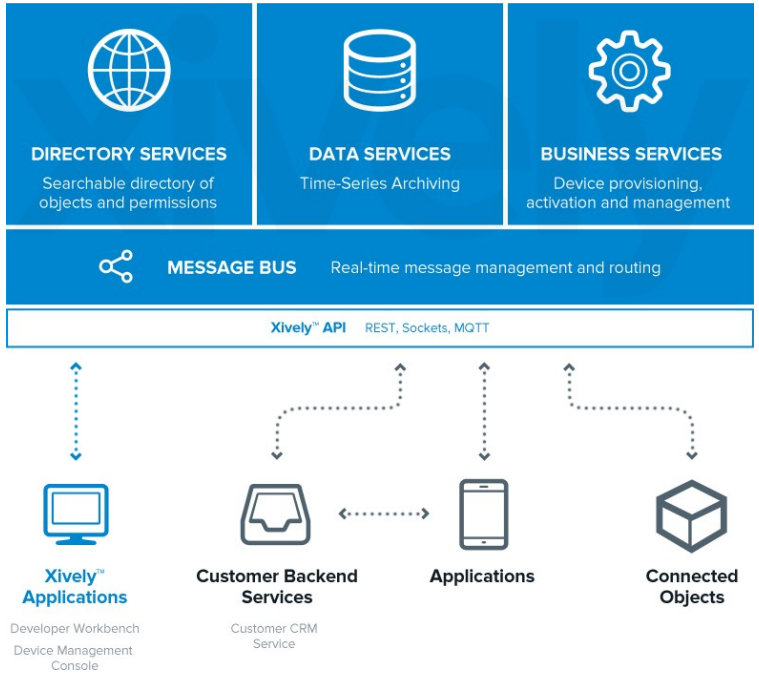


INTEL® XDK

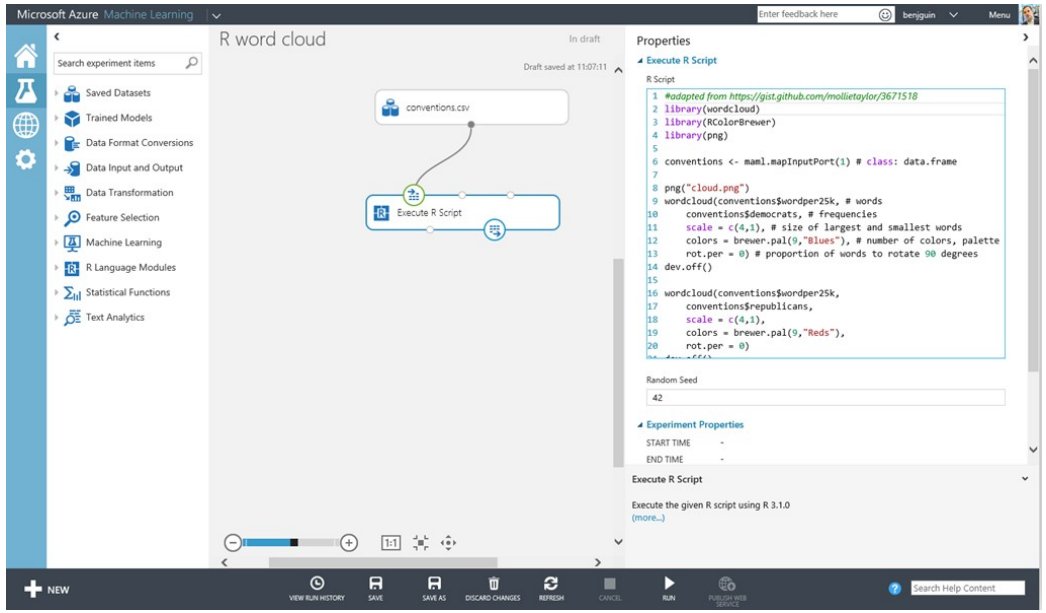


Data Acquisition and Analysis Tools

XIVELY



MICROSOFT AZURE



Visualisation Tools

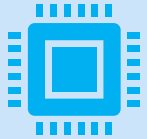
Grafana Dashboard

NodeRed UI

Summary / Recap of Main Points

IoT refers to a network of interconnected physical devices, vehicles, appliances, and other objects embedded with sensors, software, and network connectivity that enables them to collect and exchange data.

IoT allows for the seamless integration of the physical world with the digital world, creating a network of devices that can interact and collaborate to automate tasks, gather and analyze data, and improve efficiency and convenience in various domains.



By leveraging sensors and connectivity, IoT devices can collect data from their surroundings, monitor their own performance, and respond to commands or triggers. This data can then be analyzed to gain insights, make informed decisions, and optimize processes.

Review Questions

- What is the concept of IoT? How does it relate to the network of interconnected physical objects and data exchange over the Internet?
- What are the key components of IoT hardware? Briefly describe the role of each of the following: sensors, actuators, microcontrollers, and microprocessors.
- How do prototyping tools support IoT development? Provide examples of prototyping tools used for creating IoT prototypes and proofs-of-concept.
- What are data acquisition, analysis, and visualization tools in the context of IoT? How do they contribute to collecting, analyzing, representing, and interpreting IoT data? Give examples of graphical interfaces and dashboards used for IoT data visualization.

What To Expect Next Week

In Class

Preparation for Class