Programming IoT

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What is Programming?

- **Programming** is the process of creating a set of instructions that tell a computer how to perform a task or sequence of tasks.

- The engineering practice of computer programming is primarily concerned with discovering and implementing **the most efficient algorithms** to address a specific class of problem.
- Computer programming entails the use of a variety of programming languages.

Where Programming is Needed?

- The Foot Drop project has three devices which provided a comparison of movement in different parts of the leg to identify the incidence of foot drop.

  - All these devices need programming so they know what to capture, where to send the data, how to process the data, how to relay the data, etc.

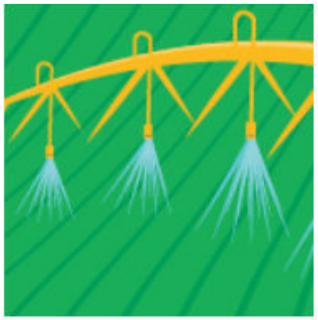
- At an application level, the programming allows the devices to talk to other devices or machines and to respond to the data with actions.

What Programming Where?

- In the table below we look at where programming is required in a smart sprinkler system.

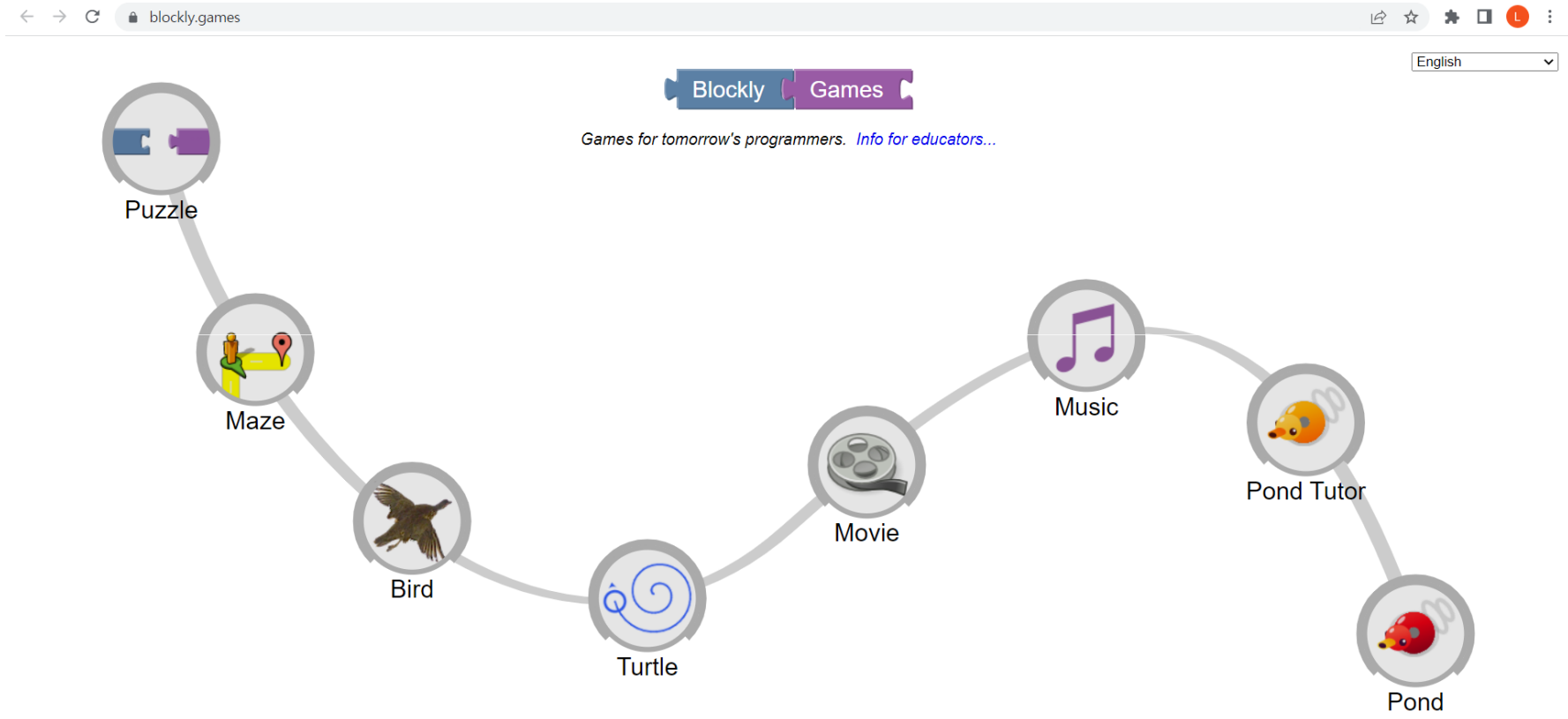
	SMART SPRINKLER SYSTEM
	Existing programming to make weather forecasts and records available online.
	Programming to read from sensor and detect moisture levels, collate and send sensor data.

What Programming Where? (cont.)

	Programming to communicate between application and actuator.
	Programming to put together weather predictions and sensor data to make smart decisions about watering time.
	Embedded programming to control water release and shut off.

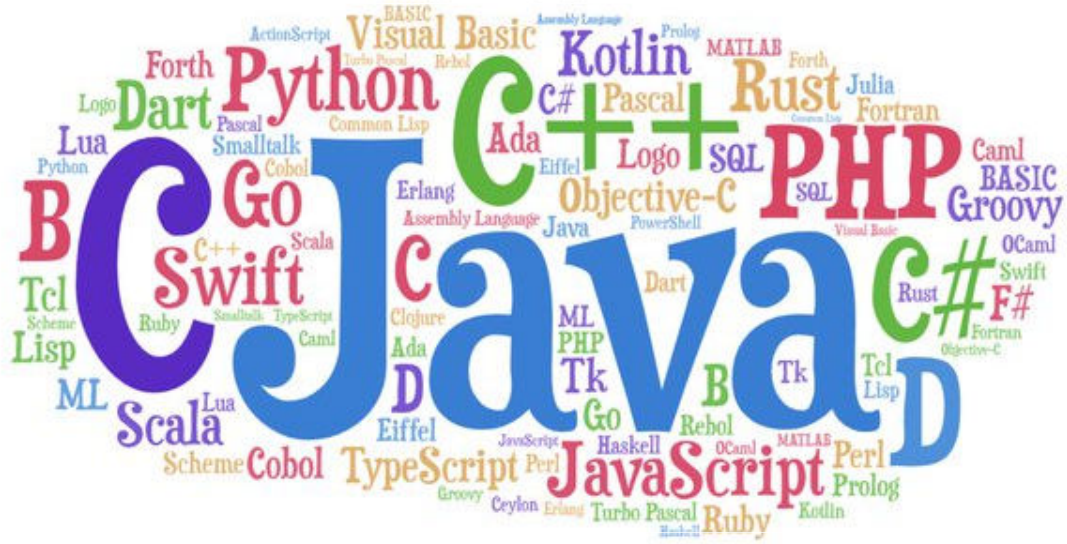
Programming

- If you have no experience of programming the following activity provides an opportunity to learn to program at an elementary level.
- **Blockly Games** is a Google project and is a series of educational games that teach programming. Click on the following link to access Blockly Games.



Programming Languages

- A **programming language** is the way of communicating with a computer. It is a set of vocabulary and grammar rules that can be used to instruct the computer.



- There are a multitude of programming languages and more created all the time.
- Choosing a programming language for IoT will likely be influenced by personal preference and the needs of your project.

Programming for IoT

- The main consideration for programming for IoT is that the small devices generally have:
  - Limited power supply
  - Limited computational power
  - Limited memory
- Zola describes 12 languages and each has something that differentiates it from other languages that might contribute to choosing it for an IoT project.

Language	Key funtionality
Assembly	Useful for compact applications
C	Useful for embedded devices
B#	Used for small applications
C++	Required when you need processing power
Go	Allows devices to work together to send and receive data in many channels simultaneously

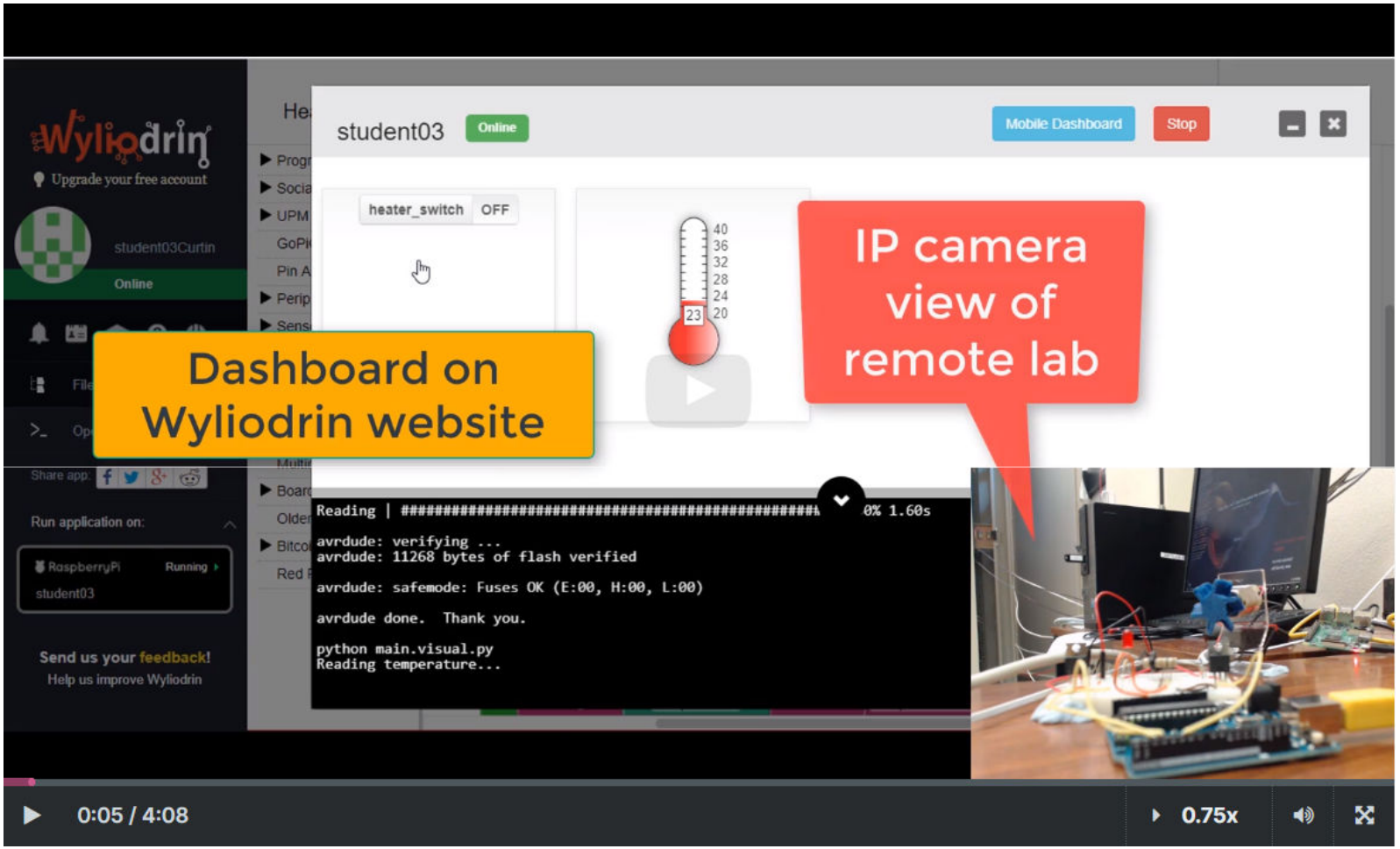
Programming for IoT

Language	Key funtionality
Java	Write it once, run it anywhere
Javascript	Omnipresent in Web applications and websites
Parasail	Useful for parallel processing
PHP	Juggle micro-services on the server
Python	Easy language to understand and utilise in IoT projects
Rust	Can share information among different channels automatically
Swift	Common language for developing iOS apps (Apple)

- This is just one view on the programming languages suitable for IoT. Other languages include; R, Form, Hive QL, Pig Latin, and Julia.

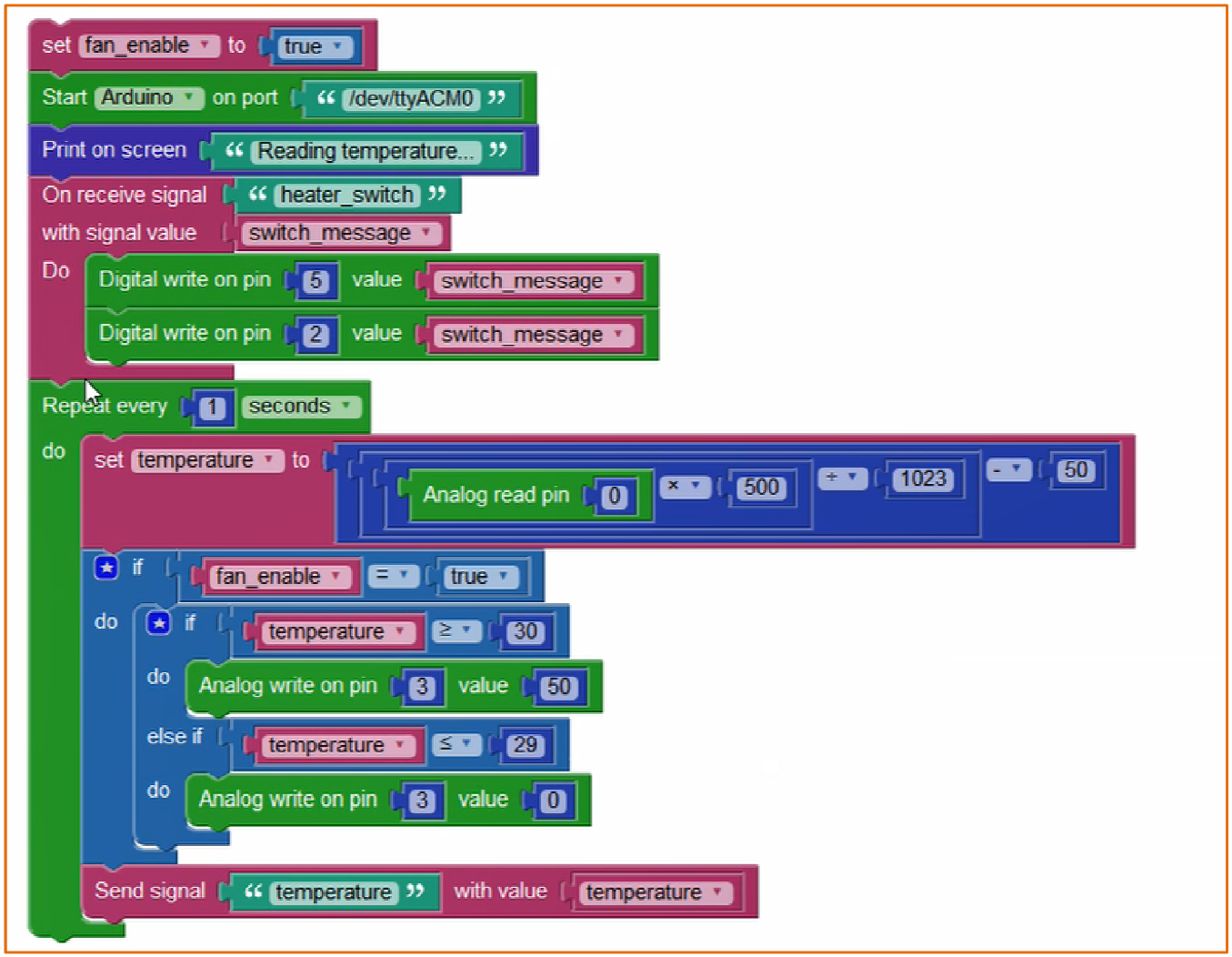
Programming a Simple Sensor - Actuator

- In this video an IoT model is set up using an Arduino microprocessor.
- The demonstration shows the programming required to automate the use of a cooling fan, and then to disable this functionality.



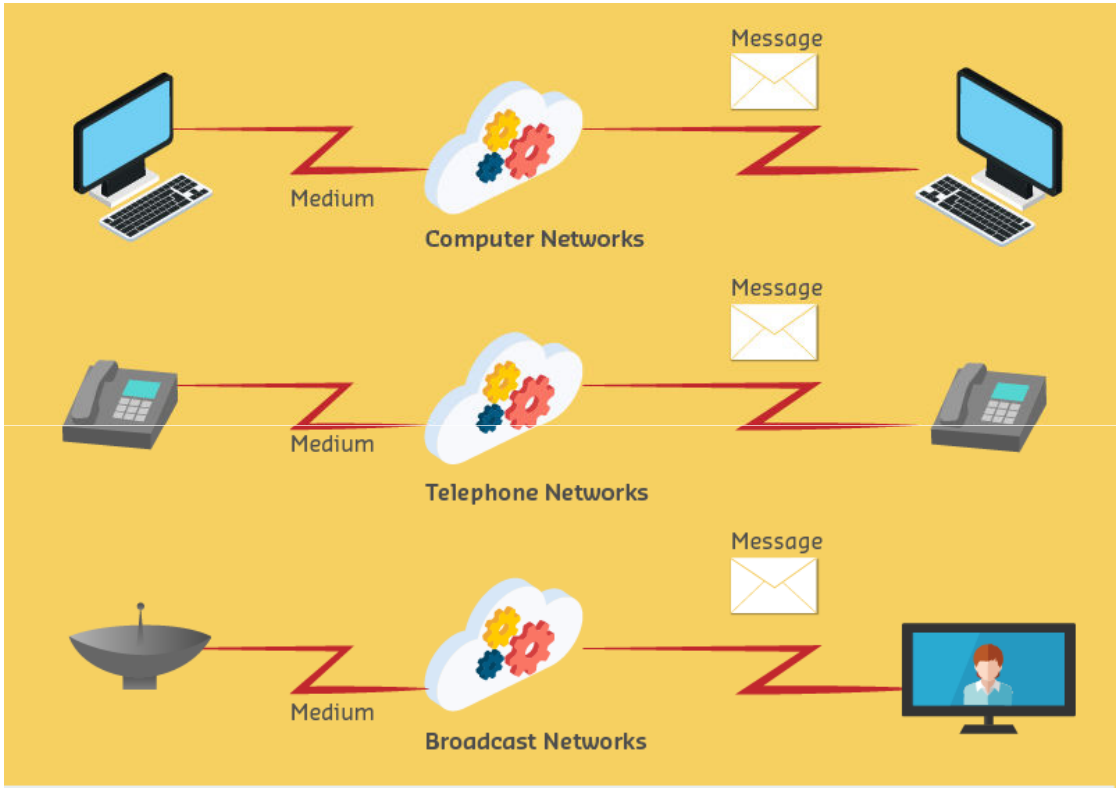
Programming a Simple Sensor – Actuator (cont.)

- If you looked at the **Blockly Games** earlier, you will recognize the similarities in the programming structure and language shown below.



What is IoT Data?

- Traditionally, information has come into our homes (and offices) in different ways:
  - **Television** uses a connection to either aerial or satellite dish
  - **Telephone** (voice) comes through the telephone connection
  - **Internet** and **email** come through an internet connection

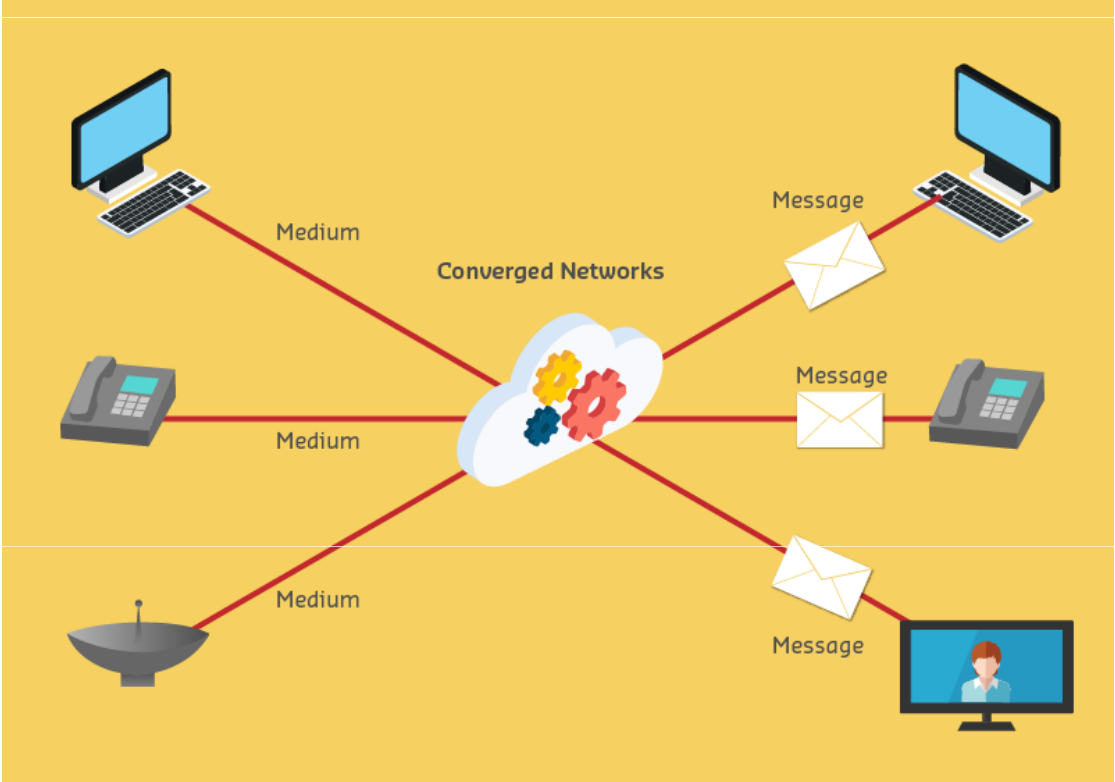


Services running on multiple seperate networks

Source: http://www.ciscopress.com/articles/article.asp?p=2164577&seqNum=6

What is IoT Data? (cont.)

- More and more, these routes are converging so that we will expect our TV, phone, internet and IoT devices to send and receive data through the same common connection.



Converged data networks carry multiple services on one network

Source: http://www.ciscopress.com/articles/article.asp?p=2164577&seqNum=6

- The information itself is all becoming digital data.

Digital Data

- **Data** can be a telephone conversation, a television program, a web page, an email, an online theatre booking, or a series of readings from a sensor or instructions to a machine.

Source: By João Batista Neto - Data types - pt br.svg, CC BY 3.0,

Digital Data (cont.)

- **Digital data** is data that is represented using a binary system of zeros (0) and ones (1).
- Visual images, speech, text, sensor readings and so on all get converted to this binary system. The data is packaged into **bytes** - bite-sized pieces that can be moved through the network from one address to another using various protocols. Bytes are sometimes split further into **Nibbles** (half the size) or **Bits** (one eighth the size of a Byte).

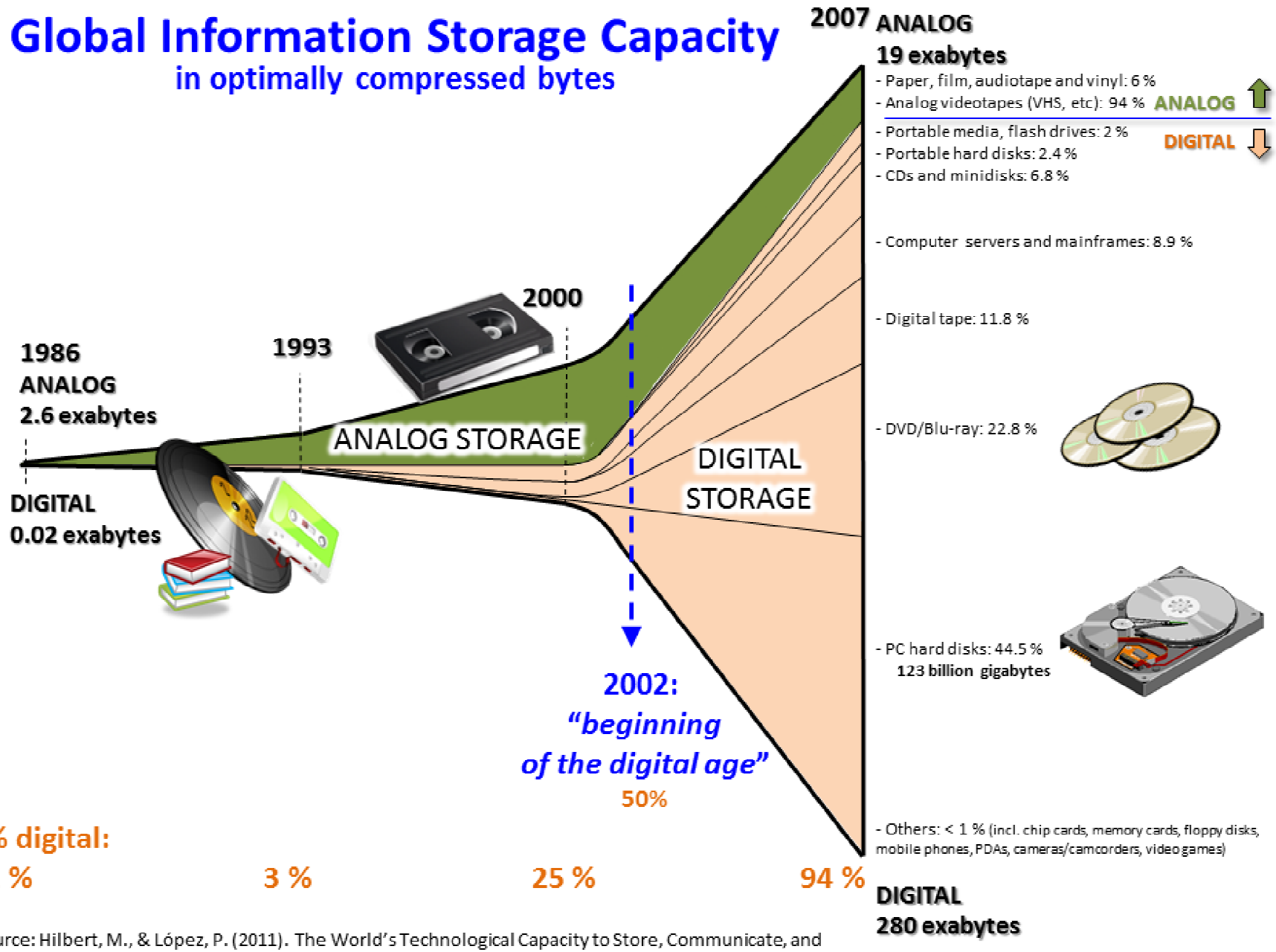
Length	Name	Example
1	Bit	0
4	Nibble	1011
8	Byte	10110101

Big Data

- **Big data** is data sets that have become so large and so complex that advanced programming and processing is required to capture the data, and then appropriately store, analyze, search, share, transfer, and visualize it.

- Big data is significantly impacted by the growth of information-sensing Internet of Things devices.

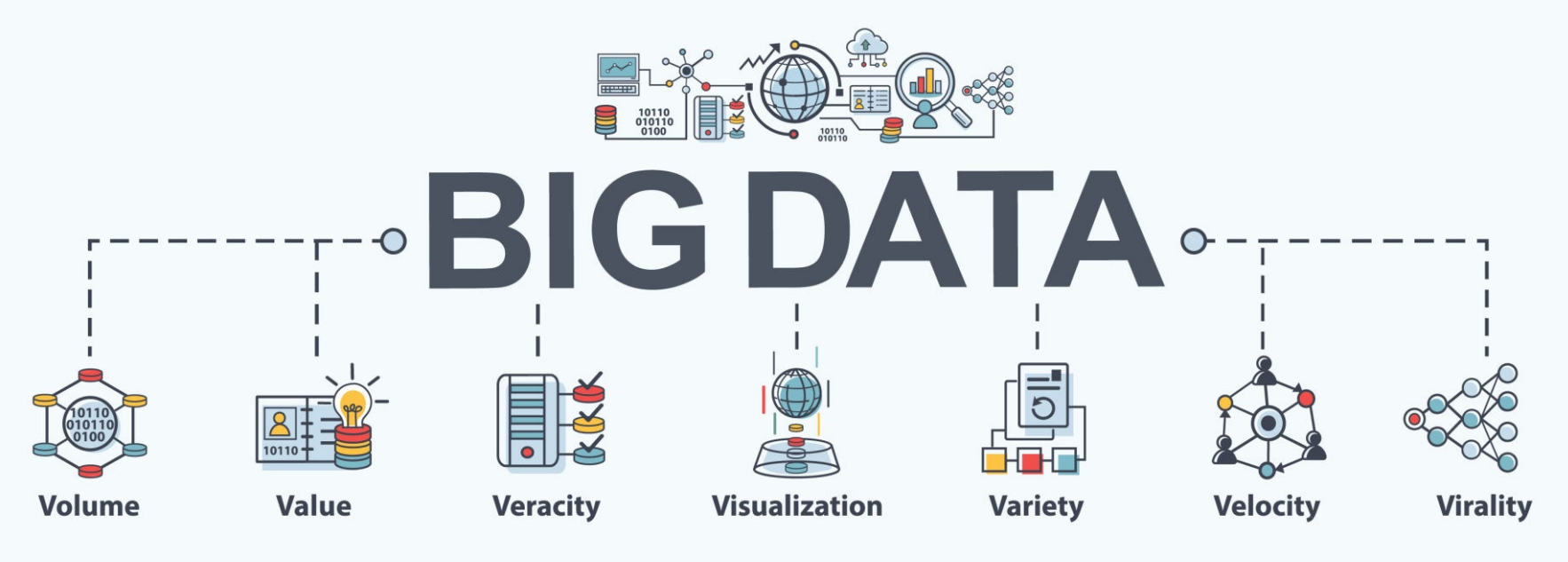
Big Data (cont.)



Source: Hilbert, M., & López, P. (2011). The World's Technological Capacity to Store, Communicate, and Compute Information. *Science*, 332(6025), 60 –65. http://www.martinhilbert.net/WorldInfoCapacity.html

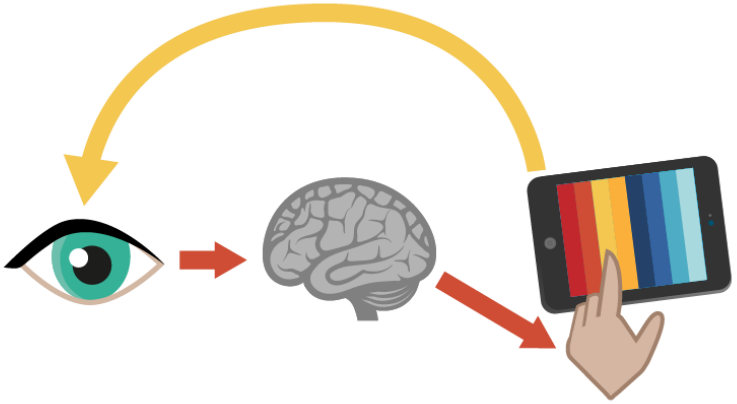
Data Types

- IBM describes the 4 V's of Big Data as:
  - **Volume** (quantity – big data observes and tracks what happens without sampling)
  - **Velocity** (speed – big data is generally available in real-time)
  - **Variety** (big data extracts from multiple sources such as text, images, audio, video)
  - **Veracity** (data quality – whether it stays true, or some is lost or damaged)



Playing with Data

- Try playing the data-sorting game Color Step on a mobile device (though you may use a computer to drag and drop colors if you don't have a touch-screen device) to start to understand this concept.
- Let's consider what was happening when you were playing that game.



The processor in this system - your brain - was undertaking several tasks in dealing with the data.

1. Receiving data (color information from the eyes).
2. Comparing data (color bands).
3. Directing the eyes where to look.
4. Directing the hands to interact with the image on the screen.

THANK YOU ALL FOR LISTENING

QUESTIONS AND ANSWERS