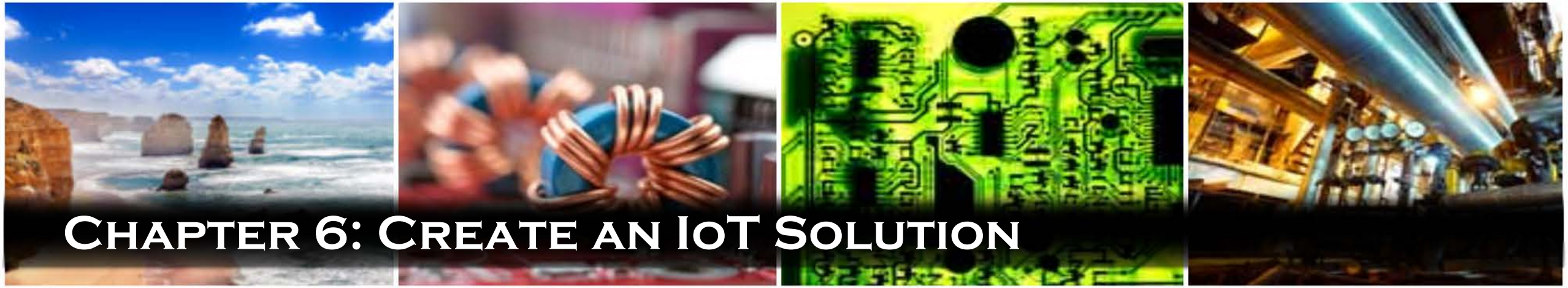

Chapter 6: Create an IoT Solution

IoT Fundamentals
Connecting Things v2.0
Instructor Training

Education Service Center Region 11
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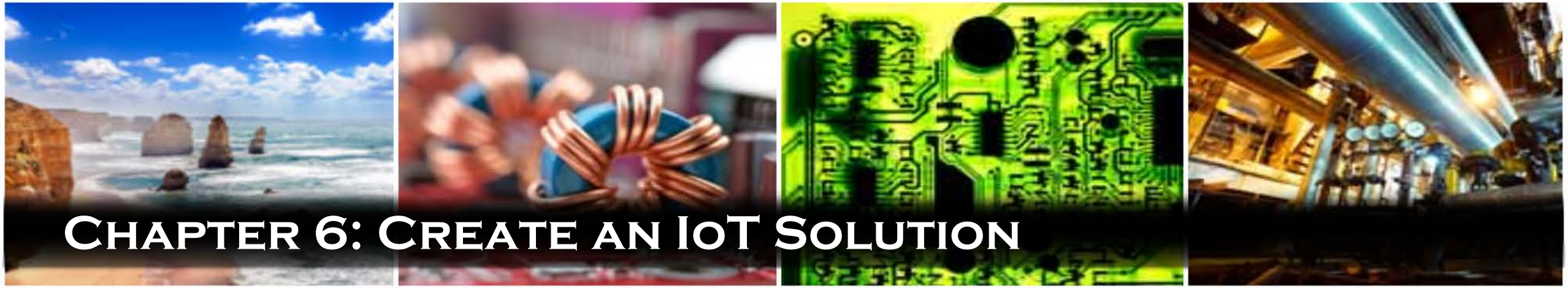

Chapter 6: Create an IoT Solution

IoT Fundamentals
Connecting Things v2.0

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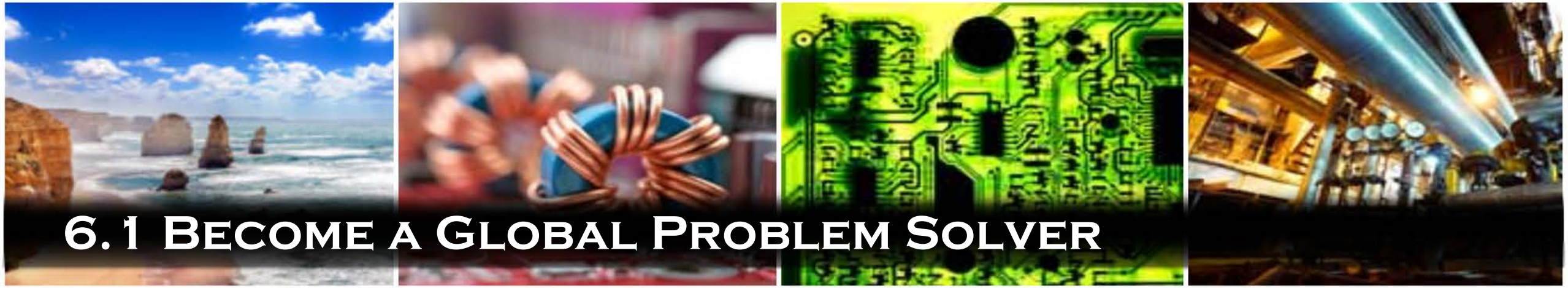
Chapter 6 - Sections & Objectives

- 6.1 Become a Global Problem Solver
  - Investigate real-world social or environmental problems
- 6.2 Design a Solution
  - Design an IoT solution that addresses a real-world social or environmental problem
- 6.3 Build, Test & Document a simple IoT System
  - Create an IoT system
- 6.4 The Business Aspects
  - Design a plan to market an IoT solution
- 6.5 What is Next?
  - Explain how to continue your learning about the IoT



6.1 Become a Global Problem Solver

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6.1.1 Solving Global Problems

- **Organizations Doing Global Good**
  - Global problems include the burning of fossil fuels, air pollution, oceans becoming more acidic, climate change, poverty, hunger, disease, gender inequality, and access to water and sanitation
  - Some companies and organizations provide funds to help these global problems such as the Bill & Melinda Gates Foundation and The Musk Foundation
- **The Millennium Development Goals**
  - In 2000, leaders from 189 countries made a list of 8 goals to be achieved in 15 years called the **Millennium Development Goals (MDGs)**
    - Eradicate extreme hunger
    - Achieve universal primary education
    - Promote gender equality and empower women
    - Reduce child mortality
    - Improve maternal health
    - Ensure environmental sustainability
    - Global partnership for development
  - United Nations Development Program (UNDP) is working on fulfilling these goals

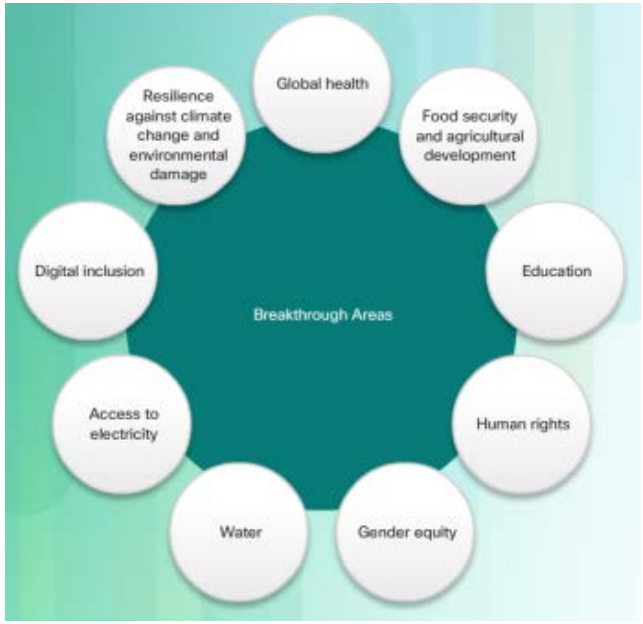
6.1.1 Solving Global Problems

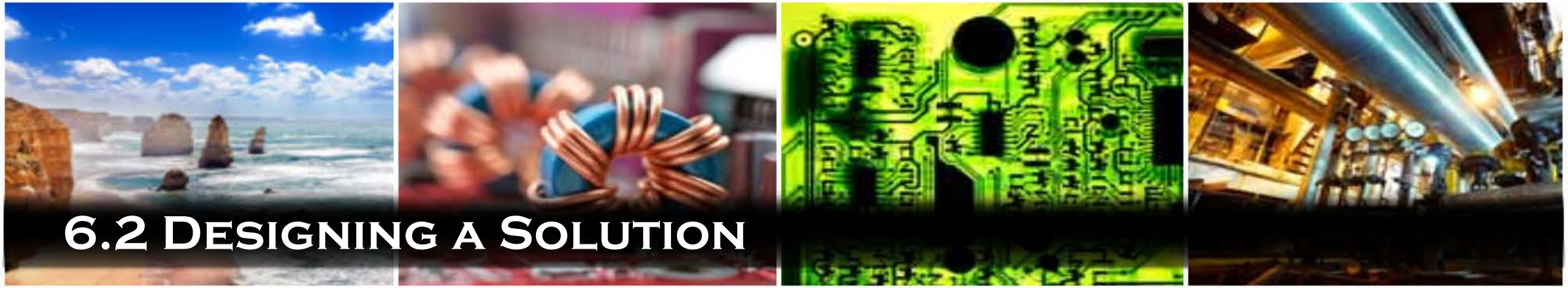
- **Progress on MDGs so far:**
  - People who live on less than $1.25 per day has dropped by more than half
  - Young children going to school is up by almost half
  - People receiving HIV treatment increased by over 15 times
  - Lowered child mortality rate by almost half

- **The Sustainable Development Goals**
  - In 2015, 189 world leaders at the United Nations Sustainable Development Summit unanimously adopted the 2030 Agenda for Sustainable Development
  - The result was a set of 17 Sustainable Development Goals (SDGs)
  - These new SDGs go much further than the MDGs
  - They are addressing the root causes of poverty and the universal need for development that works for all people

6.1.2 Globally Transformative Breakthrough Technologies

- **Lawrence Berkeley National Lab**
  - The Lawrence Berkeley National Lab (LBNL)
  - The Lawrence Institute of Globally Transformative Technologies (LIGTT) (pronounced ‘light’) is part of LBNL and was created in 2012
  - The goal of LIGTT is to leverage LBNL’s resources to develop and deploy breakthrough technologies for sustainable global development
- **Institute of Globally Transformative Technologies**
  - The LIGTT released a top "50 Breakthroughs" study in 2014
  - Identified some of the most important breakthrough technologies that are required for sustainable global development
  - LIGTT aims to develop many of these breakthroughs
  - Achieving this will make substantial impacts on poverty
  - Breakthrough #42 is directly related to using the IoT to enable new services

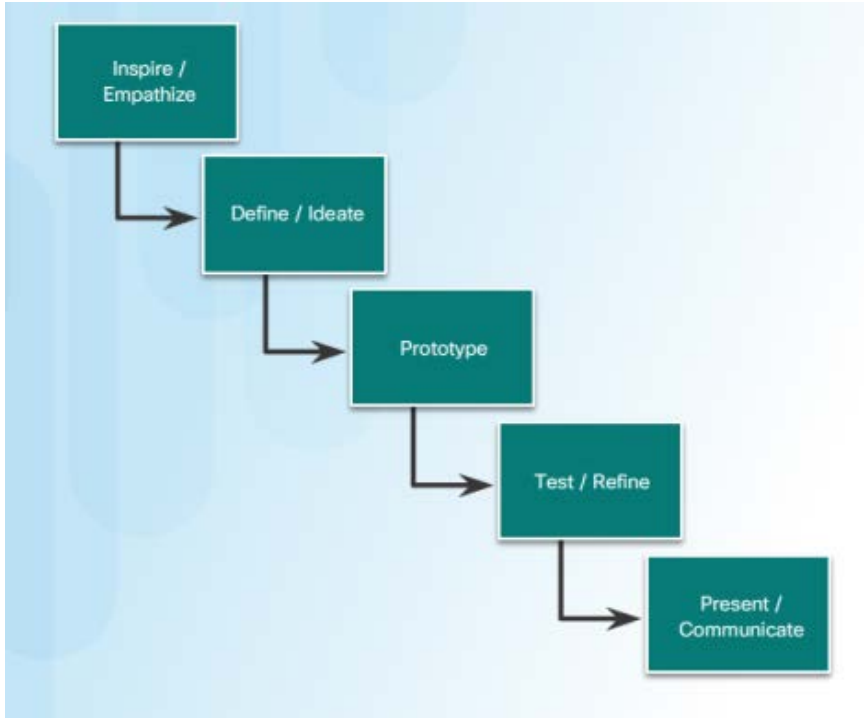




6.2 Designing a Solution

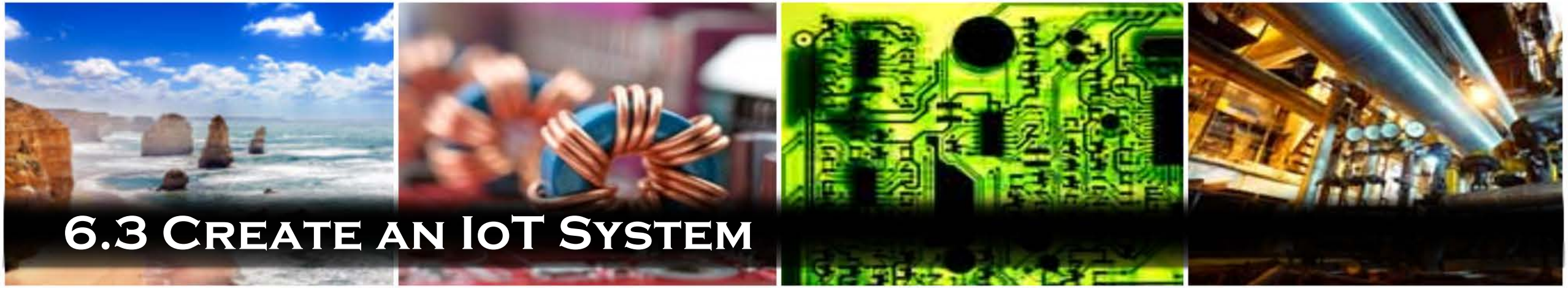
6.2.1 Designing Solutions

- **The Engineering Design Process**
  - How can we help solve global challenges?
  - The engineering design process is a proven method
  - The five steps in the design process:
    - Inspire/Empathize
    - Define/Ideate
    - Prototype
    - Test/Refine
    - Present/Communicate
  - Steps are cyclical which means that they can be repeated as many times as needed to make improvements in the design process



6.2.1 Designing Solutions

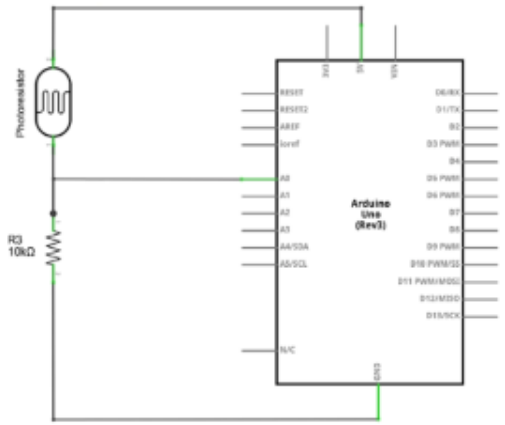
- **Security Design**
  - Security should be included from the beginning, in the design phase
  - Ensure new devices facilitate software updates and all hidden backdoors are removed
  - On pre-manufactured (off the shelf) devices used in projects ensure the following:
    - Default passwords/usernames are changed
    - UPnP is disabled on IoT devices if possible
    - Remote device management is protected with strong passwords and access limited to trusted personnel
    - Ensure all devices are updated with the latest software updates and patches
    - Ensure all devices support and use encryption and certificates
    - Secure the physical location of IoT devices as much as possible



6.3 Create an IoT System

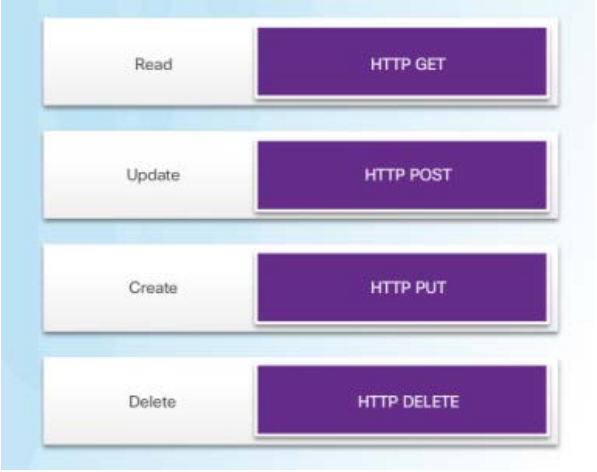
6.3.1 THE IoT System Project

- **Project Overview**
  - Identify a problem that can be solved by an IoT device
  - Example used: building a device that senses the amount of light and determines sunrise and sunset
- **The Circuit Layout**
  - Electronic components have specific power, polarity, and connection requirements.
  - The circuit layout identifies/describes these requirements
  - Sunrise/sunset example requires a voltage divider - produces an output voltage that is a fraction of its input voltage by distributing the input voltage among the components of the divider



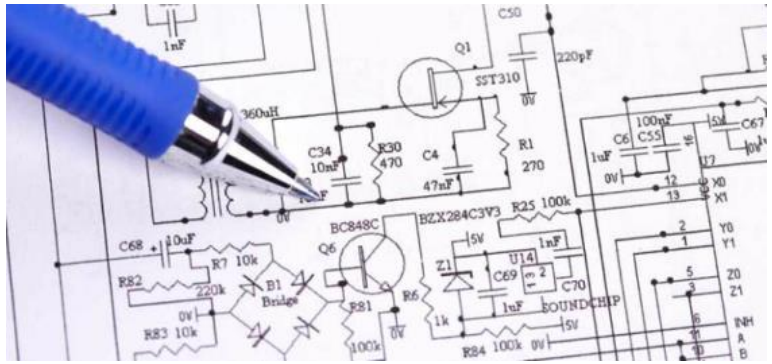
6.3.1 THE IoT System Project

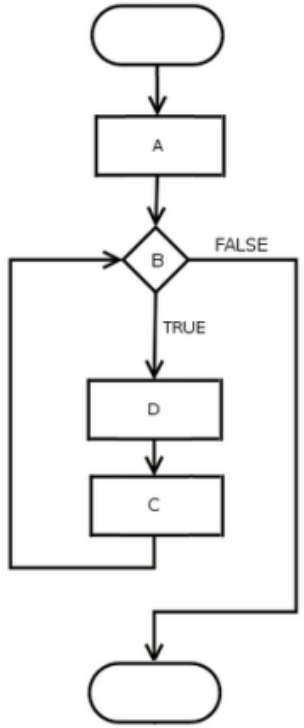
- **REST API in an IoT System**
  - REST APIs use HTTP methods to exchange data between systems or applications
  - RESTful systems use Uniform Resource Identifiers (URIs) to represent their services to external systems
  - Sample RESTful URIs:
    - **GET** –initiates a read action
    - **POST** –initiates a update action
    - **PUT** – initiates a create action
    - **DETELE** – initiates a delete action
  - The IFTTT web service allows for special resource URIs to be created and mapped to specific IFTTT actions.
  - Example IFTTT URI - **https://maker.ifttt.com/trigger/SunRise/with/key/**
  - The sunrise/sunset example uses both IFTTT and Google Calendar service
  - Hypermedia uses hyperlink references that point to images, audio, or video
  - A secret key ensures that an IFTTT URI is only usable by the authorized device



6.3.1 THE IoT System Project

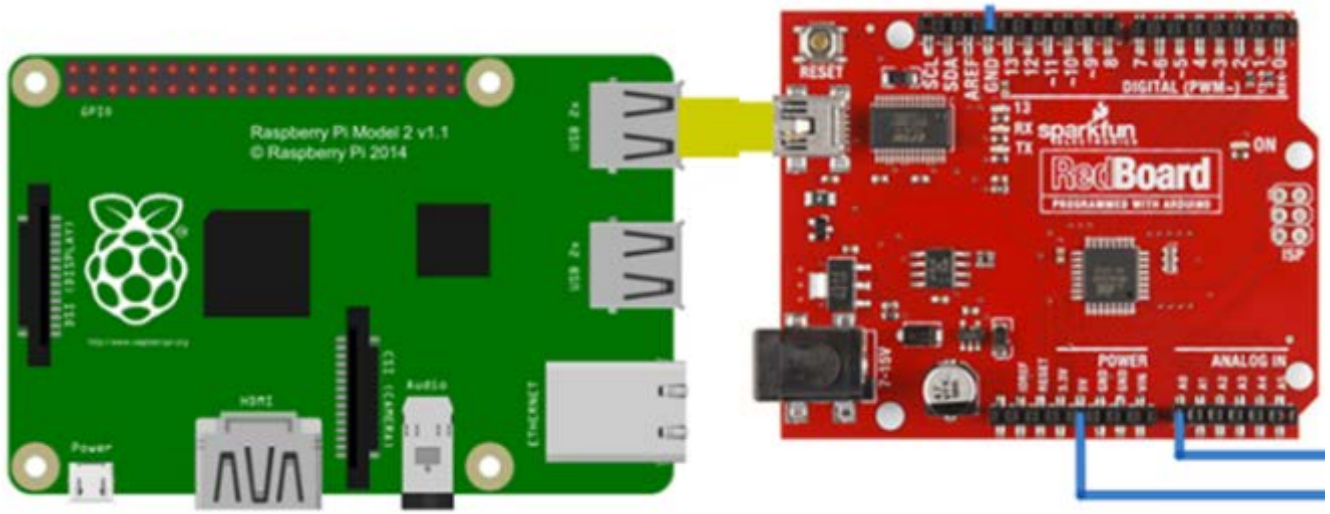
- **Flowcharts, Electronic Schematics, and Sequence Diagrams**
  - Documenting the project is very important for building the devices, testing, troubleshooting, and creating a business model
  - **Flowcharts** use standardized symbols to represent the processes and documented through the solution workflow
    - The diamond symbol is used to represent a decision
    - The rectangle symbol is used to represent a processing step (activity)
  - **Electronic schematics** is a graphical representation of a circuit diagram using internationally standardized components
  - **Sequence diagrams** represent interactions between entities along a timeline





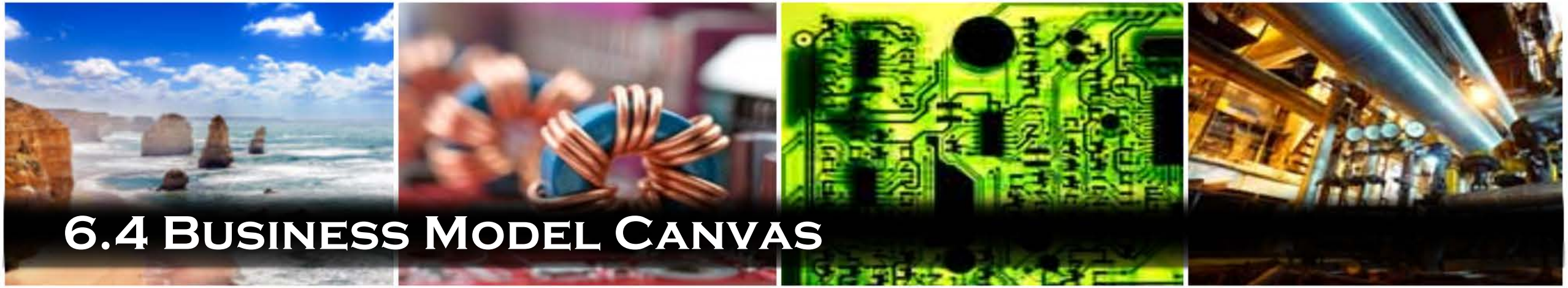
6.3.1 THE IoT System Project

- **The Code**
  - The sunrise/sunset example is written in Python using a Raspberry Pi
  - The Arduino is connected to the Raspberry Pi
  - The programming is done on the Raspberry Pi to send the level of voltage drop from the Arduino to the RaPi
  - **Firmata**, a generic protocol for communicating with microcontrollers, is used to communicate between the Arduino firmware and the Raspberry Pi
  - The Python code used for the sunrise/sunset example is explained line by line



6.3.2 THE IoT System Prototype

- **Overview of the Problem**
  - Simple problem identified that can be solved by an IoT system: remote access to determine if garage door is open or closed
    - Switch can determine if a door is open or closed
    - Switch attaches to a controller – which keeps track of switch status
    - Controller connected to Internet to provide remote access
- **Prototyping and testing System**
  - Create electronic schematic, flowchart, and sequence diagram for prototype
  - Packet Tracer 7 used to create and test the prototype
  - Update documentation once prototype works successfully
  - Documenting is important not only for future reference but also for situations where marketing material or patent applications are to be created
  - To prevent radio interference from unconnected analog pins on a circuit board connect them to ground and connect them to the battery



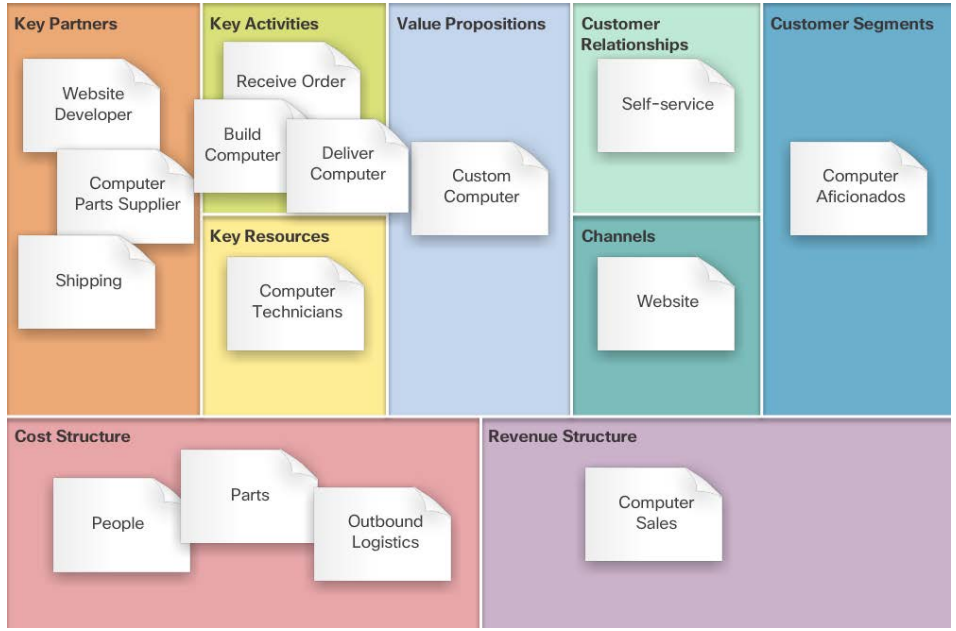
6.4 Business Model Canvas

6.4.1 Business Model Canvas

- **Business Model Canvas Overview**
  - Helps organizations and entrepreneurs map, discuss, design, and invent new business models based on a value proposition, customer interface, infrastructure management, and finances
  - A business model consists of nine building blocks:
    - **Customer Segments** - Identifies the users and customers of the organization
    - **Value Proposition** – Identifies the product or service the organization will provide to the customer segment
    - **Channels** - Identifies how an organization will deliver the value to the customer segments
    - **Customer Relationship** - Describes the type of relationship that will be established with the customer
    - **Revenue Stream** - Identifies how and through which pricing mechanism the organization is capturing value
    - **Key Resources** - Identifies the infrastructure required to create value and shows which assets are indispensable in the organization model
    - **Key Activities** - Identifies which activities the organization is required to perform well
    - **Key Partnerships** - Identifies who can help the organization leverage the business model
    - **Cost Structure** - Identifies the cost of the operation

6.4.1 Business Model Canvas

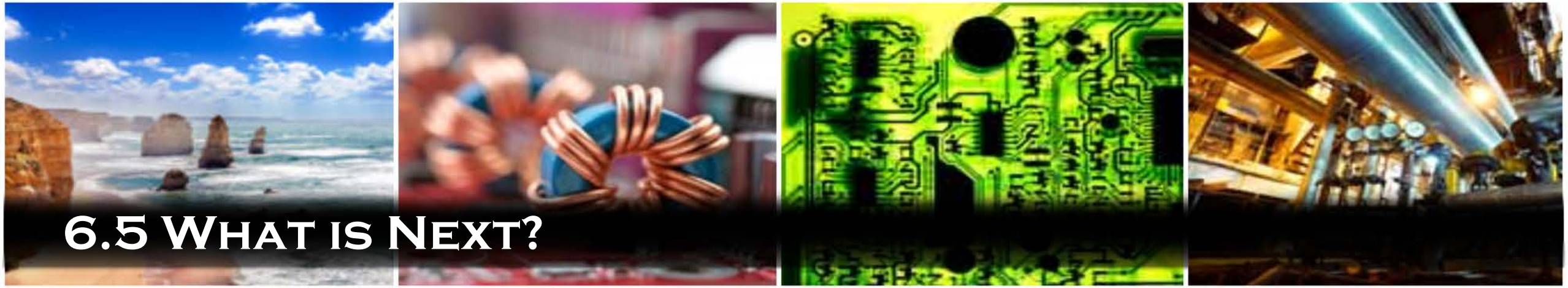
- **Infrastructure Management**
  - Defines how to build the value proposition
  - Covered by three blocks: Key Resources, Key Activities, and Key Partnerships
- **Customer Interface**
  - Covered by four blocks: Value Proposition, Customer Relationships, Channels, and Customer Segment
- **Business Finances**
  - Covered by two blocks: cost structure and revenue structure created by the value proposition



6.4.1 Business Model Canvas

- **Business Model Canvas Example**
  - Example of a completed business model canvas for a custom computer manufacturer
  - An example of a company or entrepreneur using the Business Model Canvas is using sticky notes on a large surface
  - The operations block of the Business Model Canvas is associated with transforming inputs into offerings
  - Rent is an example of a fixed cost because it does not change based on the amount of product produced
  - Facilitating an exchange of value for offerings is associated with the marketing and sales activity of a product or service in the Business Model Canvas

- Canvanizer – https://canvanizer.com

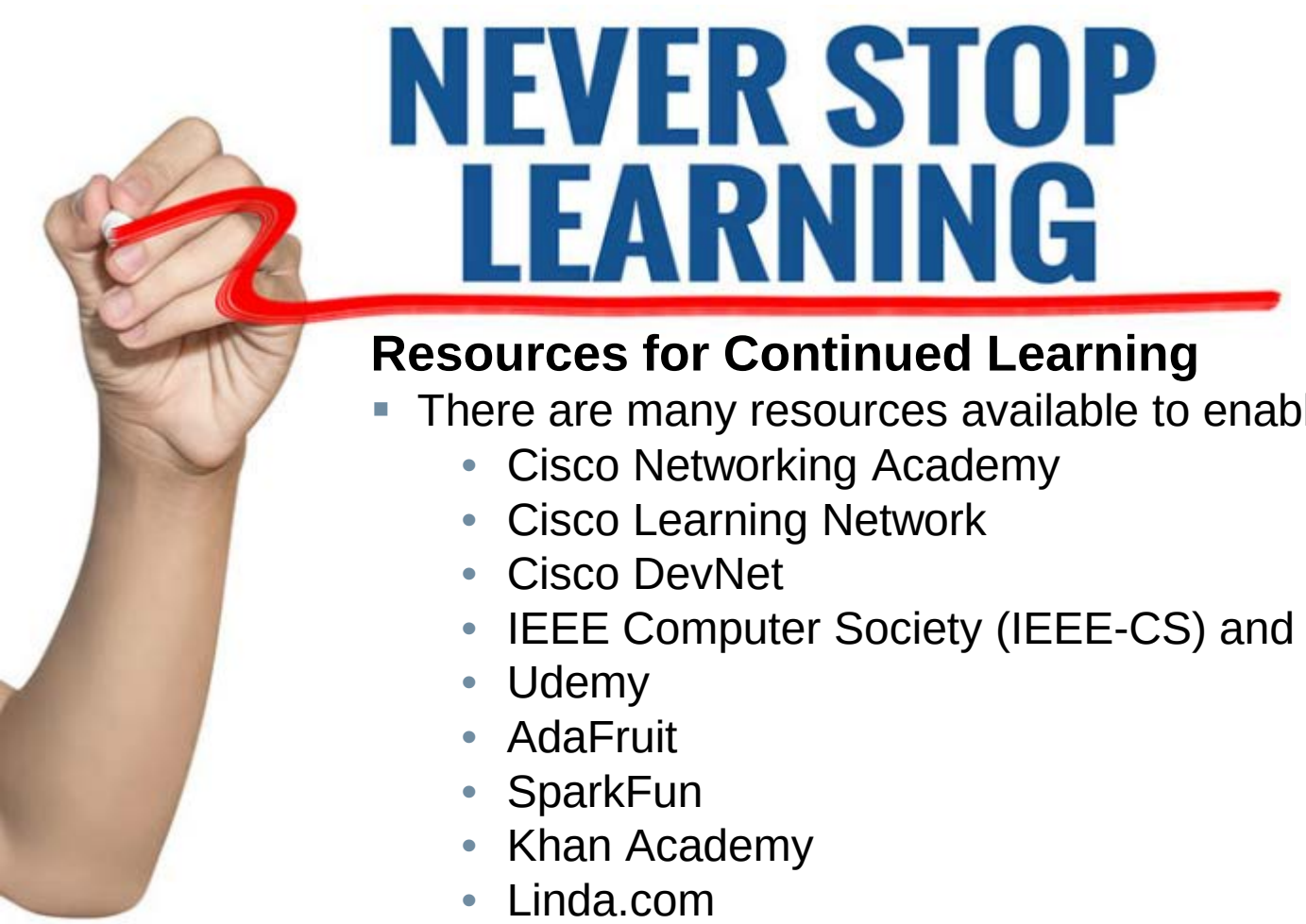


6.5 What is Next?

6.5.1 Lifelong Learning

- **21st Century Skills**
  - 21st century job market is now looking for employees who can accomplish one or more job roles such as: design a project, prototype a device, create and maintain documentation, and create a business plan
  - IoT professionals should be individuals who espouse life-long learning
  - They need to be:
    - Flexible
    - Take the initiative
    - Lead when necessary
    - Be able to produce something new and useful
  - IoT employees also need learning and innovation skills
    - Creativity and innovation
    - Critical thinking and problem solving
    - Communication
    - Collaboration

6.5.1 Lifelong Learning



Resources for Continued Learning

- There are many resources available to enable you to continue learning about the IoT including:
  - Cisco Networking Academy
  - Cisco Learning Network
  - Cisco DevNet
  - IEEE Computer Society (IEEE-CS) and the Association for Computing Machinery (ACM)
  - Udemy
  - AdaFruit
  - SparkFun
  - Khan Academy
  - Linda.com
  - Many other online resources including forums, wikis, blogs, and more
  - There are also IoT communities of practice consisting of other like-minded individuals who want to share ideas with others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