Instructor Materials
Chapter 6 Create an IoT Solution

IoT Fundamentals

Connecting Things v2.01

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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.
  - These eight goals were called the Millennium Development Goals (MDGs).
  - United Nations Development Programme (UNDP) is working on fulfilling these goals.
  - 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.
      - .

Solving Global Problems (Cont.)

- 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 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

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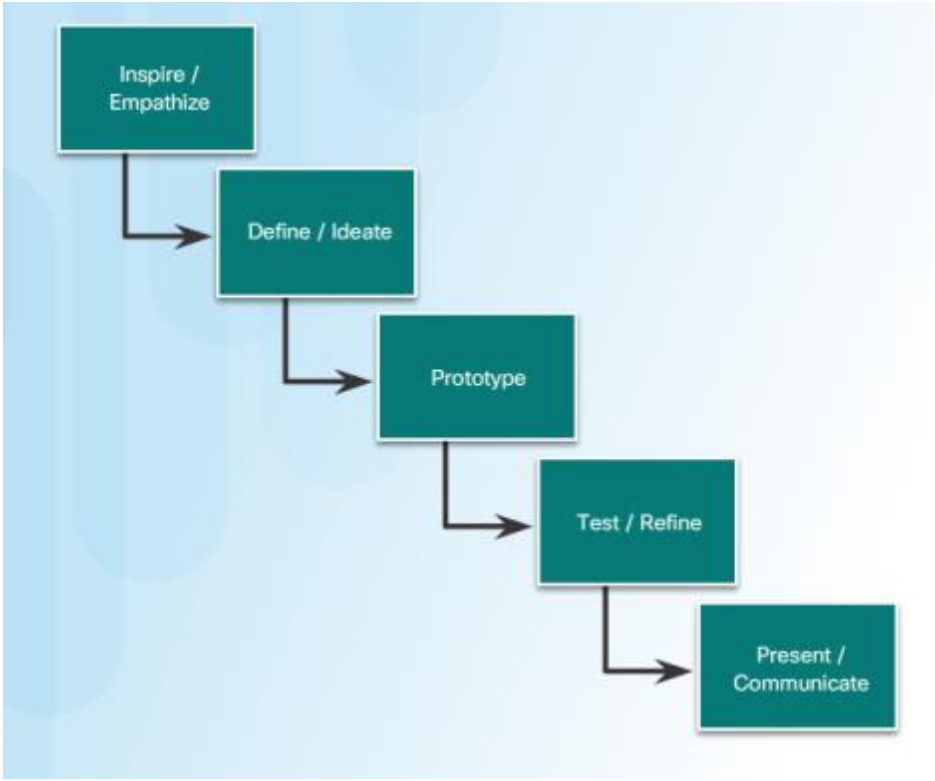
6.2.1 Designing Solutions

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



6.2.1 Designing Solutions (Cont.)

- 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 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

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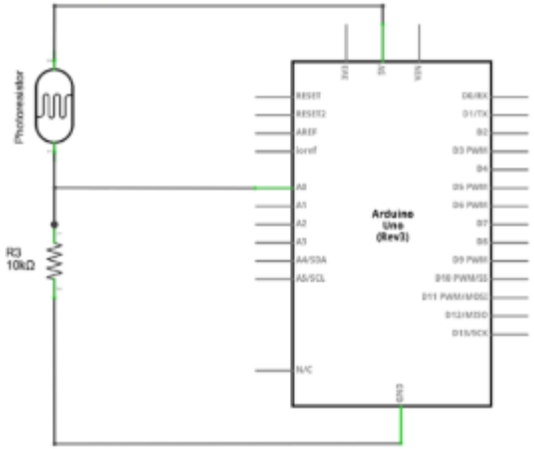
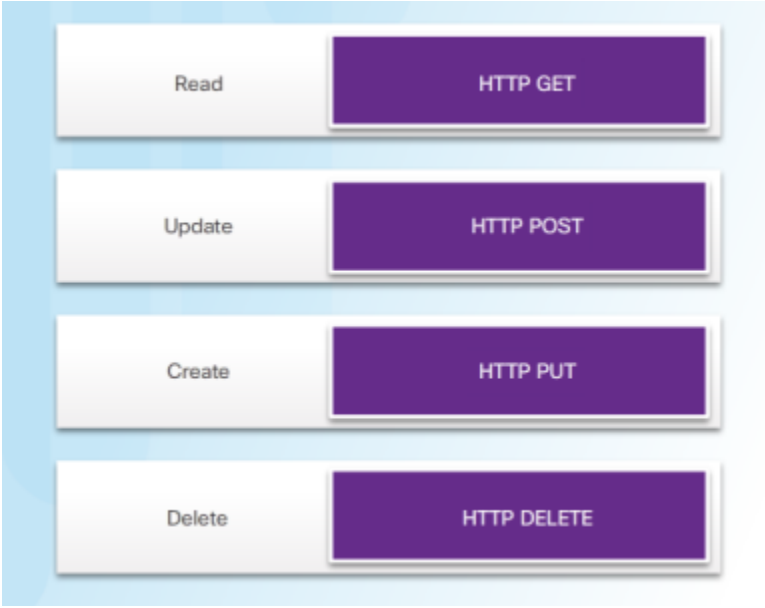
6.3.1 THE IoT System Project

- Project Overview
  - Identify a problem that can be solved by an IoT device.
  - Example used: building a device that senses the amount of 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 (cont'd)

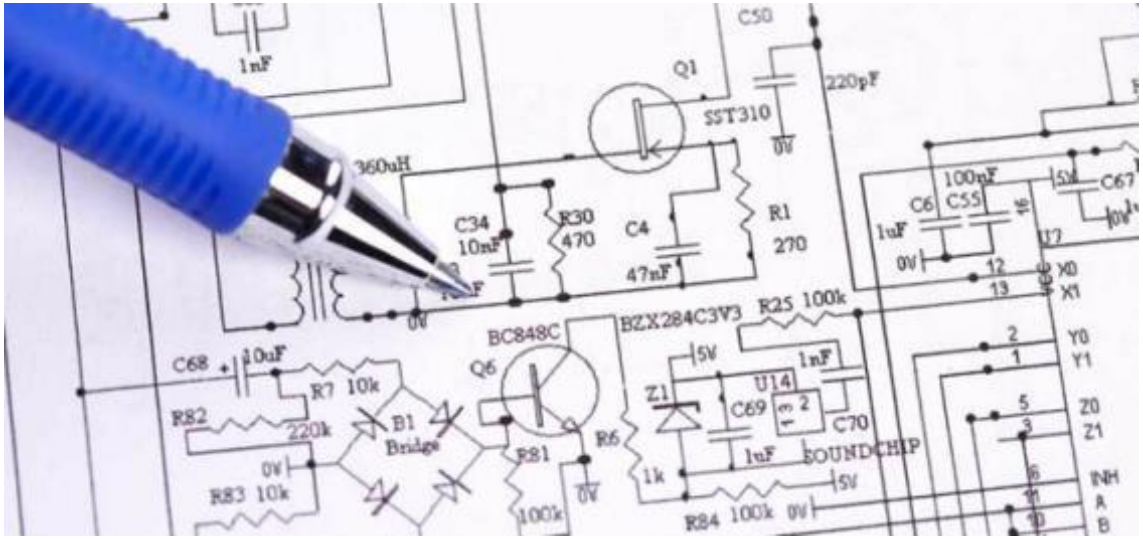
- REST API in an IoT System
  - REST APIs use HTTP methods to exchange data between systems or applications
  - RESTful systems use Uniform Resource Identifiers (URIs) to represent their services to external systems.
  - Sample URIs:
    - GET /people/michael to receive Michael's user profile dataset
    - POST /people/michael to update Michael's profile with new data.

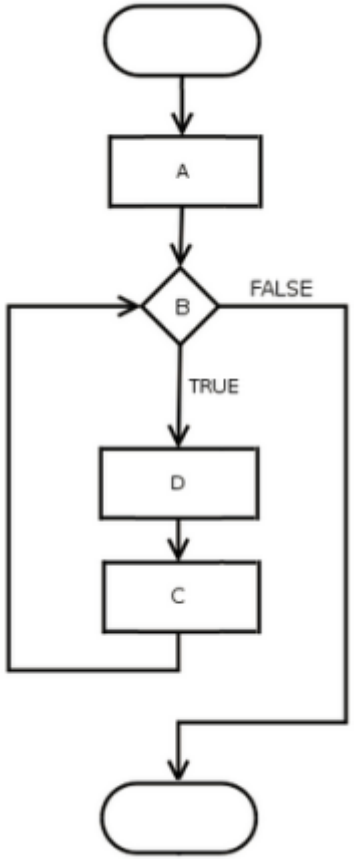


- The IFTTT web service allows for special resource URIs to be created and mapped to specific IFTTT actions.
- Example IFTTT URI - **https://maker.ifttt.com/trigger/SunRise/with/key/**
- The sunrise/sunset example uses both IFTTT and Google Calendar services

6.3.1 THE IoT System Project (cont'd)

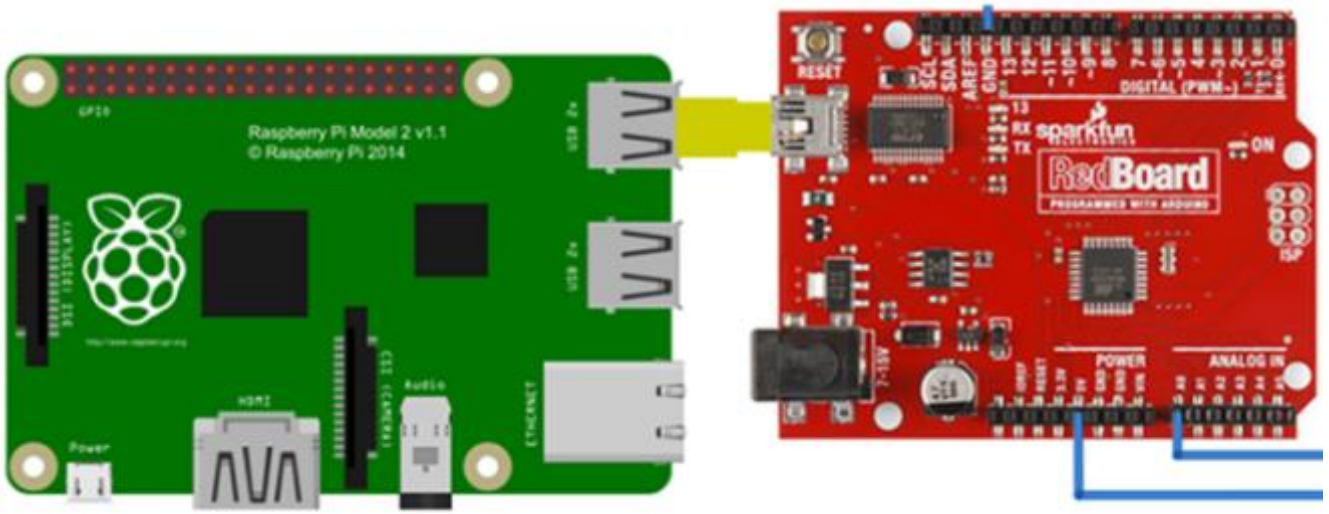
- Flowcharts, Electronic Schematics, and Sequence Diagrams
  - Documenting project is very important for building the devices, testing, troubleshooting, and creating a business model.
  - Flowcharts use standardized symbols to represent the processes and workflows.
  - Electronic schematics is a graphical 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 (cont'd)

- 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 RaPi.
  - 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.

6.4 The Business Aspects

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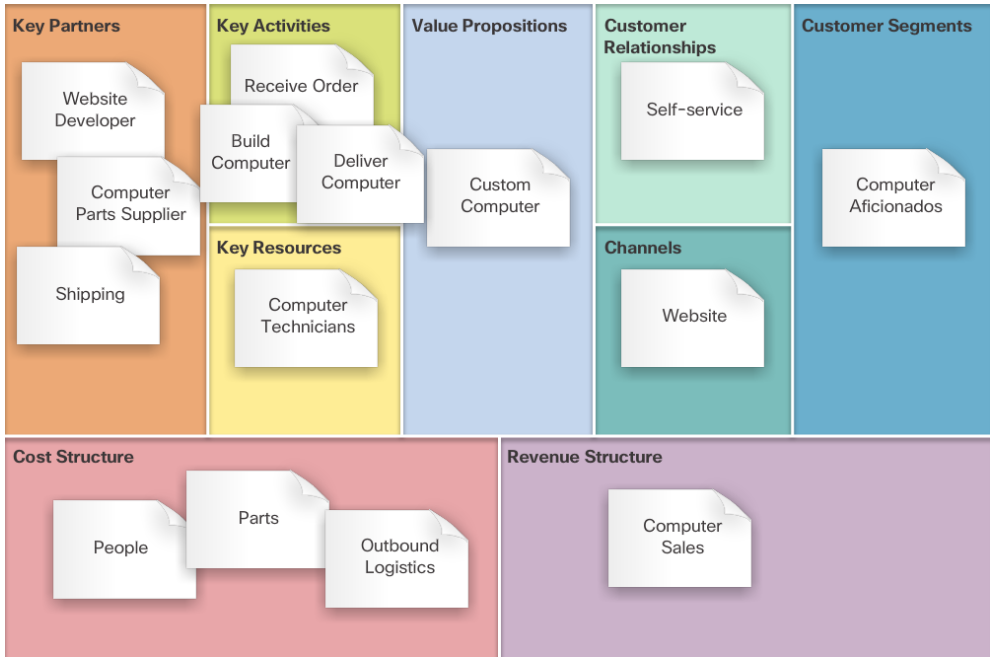
6.4.1 Business Model Canvas

- Business Model Canvas Overview
  - Helps organizations and entrepreneurs map, discuss, design, and invent new business models.
  - A business model consists of nine building blocks:
    - Customer Segments, Value Proposition, Channels, Customer Relationships, Revenue Stream, Key Resources, Key Activities, Key Partnerships and Cost Structure.
- Customer Interface
  - Customer Interface is comprised by Customer Segments, Value Proposition, Channels, Customer Relationship.
- Infrastructure Management
  - Defines how to build the value proposition.
  - Key Resources, Key Activities, and Key Partnerships make up the Infrastructure Management.

6.4.1 Business Model Canvas (Cont.)

- Business Finances
  - Include the cost structure and revenue streams created by the value proposition.

- Business Model Canvas Example
  - Example of a completed business model canvas for a custom computer manufacturer.



6.5 What is Next?

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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 employees also need learning and innovation skills
  - Creativity and innovation
  - Critical thinking and problem solving
  - Communication
  - Collaboration

What is Next?
6.5.1 Lifelong Learning (cont'd)

- 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)
    - 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.

6.6 Chapter Summary

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Summary

- There are many global social and environmental problems that can be solved by IoT systems. The Institute for Globally Transformative Technologies (LIGTT) has compiled a list of 50 breakthrough technologies that will drastically improve the work on these global problems.
- The Engineering Design Process is a proven method to develop a product.
- The first step to design an IoT solution is to identify a problem that can be solved with an IoT device. To test the idea, a prototype could be built simply by using a Raspberry Pi with an attached Arduino. To provide an example, a sunrise/sunset tracker was built.
- Another prototype was designed on Packet Tracer to remotely check to see if the garage door was open or closed..
- Documentation is very important component of any project. Flowcharts, Electronic Schematics and sequence diagrams are often used to provide documentation.
- The **Business Model Canvas** helps organizations and entrepreneurs map, discuss, design, and invent new business models based on a value proposition, customer interface, infrastructure management, and finances
- IoT professionals should be individuals who espouse life-long learning. They need to be flexible, take the initiative, lead when necessary, and be able to produce something new and useful