



Distributed & Embedded Real-Time Systems

(0640751)

Lecture (9)

DERTS Design Requirements (5): Design based on Single Board

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Lecture Outline:

- Features of single board microcontrollers.
- Design using single board.
- Examples of Single board microcontrollers.
- Selection Criteria of suitable board.
- Board interfacing.
- Single board wireless communications.

Single-board Microcontrollers:

- A single-board microcontroller is a microcontroller built onto a single board that provides all of the interface circuits required for single-board system design.
- It includes I/O channels for digital and analog signals, EPROM and RAM, clock generator, and other support circuits for wireless communications.
- Such a board is very useful in developing the required system without needing to spend time and/or effort in developing the controller hardware.
- These boards are usually low-cost hardware, and have normally low capital cost for development.
- A single-board microcontroller differs from a single-board computer in that it has no general purpose user interface and mass storage interfaces that a more general-purpose computer would have.

Microcontroller-Board Families:

There are different boards using different microcontrollers with several features. The most common microcontroller boards are:

- **Intel Boards:** based on Intel microcontrollers.
- **ARM Boards:** based on ARM7 microcontrollers.
- **Cortex Boards:** based on Cortex microcontrollers.
- **AVR Boards:** based on Atmel AVR microcontrollers.
- **MSP430 Boards:** based on Texas Instruments microcontrollers.
- **PIC Boards:** based on the Microchip PIC microcontrollers.
- **Motorola Boards:** based on Motorola microcontrollers.
- **ARDUNIO Boards:** based on Atmel AVR microcontrollers.

Microcontroller Boards Comparison:

Specifications	Boards						
	PIC ICSP	Olimex PIC-IO	Olimex SAM7-LA2	STM32	Open 1343-P-A	EK-EVALBOT	Arduino UNO
Microcontroller	PIC16F877A	PIC16F628	Atmel AT91SAM7A2	STM32L152RB T6	ARM Cortex-M3 LPC	Stellaris LM3S9B92	ATmega 328
Operating Voltage	USB or 6-12V	12V	USB or 6V	USB or 3.3 or 5V	2-3.6V	USB or Battery	USB or 5 V
Digital I/O Pins	33	16	EPI	51	42	EPI	14
Analog I/P Pins	8	4	EPI	EPI	8	16	8
Flash Memory	8KB	2KB	1MB	128KB	32 KB	256K	32 KB
SRAM	368B	224B	16K	16KB	8KB	96K	2 KB
Clock Speed	20MHz	20MHz	30MHz	32MHz	72 MHz	80MHz	16 MHz
Others	- RS232 port. - ICSP Program Emulator Interface.	- RS232 interf. i/ps. - 4 Optocoupler o/ps. - 4 relay o/ps.	- Ethernet 10/100. - CAN driver. - RS232 interface. - SD/MMC card connector.	- Interface: I2C, SPI, USART. - IDD current measurement. - LCD Display. - Touch sensor.	Interfaces: 1 x SPI, 1 x SSP, 1 x UART, 1 x I2C, 11 x PWM, 8 x ADC	- Ethernet interface. - Wireless port. - Robot features. - DC motor control.	- UART serial communication. - Supports I ² C & SPI comm.
Cost (NOK)	89.19	176.17	132	174.93	344.08	1942	95.05

EPI: External Peripheral Interface.

Arduino Microcontroller Boards Comparison:

Arduino is becoming one of the most popular microcontrollers used in industrial applications and robotics. There are different types of Arduino microcontroller boards which differ in their design and specifications.

Specifications	Board							
	Arduino Mini Light	Arduino Pro Mini	Arduino UNO	Arduino Lilypad	Arduino Pro	Arduino Duemilanove	Arduino Bluetooth	Arduino MEGA
Microcontroller	ATmega 168	ATmega 168	ATmega 328	ATmega 328	ATmega 168	ATmega 168	ATmega 168	ATmega 1280
Operating Voltage	5 V	3.3V or 5V	5 V	2.7-5.5 V	3.3 V	5 V	5 V	5 V
Input Voltage	7-9 V	3.35-12 V	7-12 V	2.7-5.5 V	3.35-12 V	7-12 V	1.2-5.5 V	7-12 V
Digital I/O Pins	14	14	14	14	14	14	14	54
Analog I/P Pins	8	6	8	6	6	6	8	16
DC Current per I/O Pin	40 mA	40 mA	40 mA	40 mA	40 mA	40 mA	40 mA	40 mA
Flash Memory	16 KB	16 KB	32 KB	16 KB	16 KB	16 KB	16 KB	128 KB
SRAM	1 KB	1 KB	2 KB	1 KB	1 KB	1 KB	1 KB	8 KB
EEPROM	512 Bytes	512 Bytes	1 KB	512 Bytes	512 Bytes	512 Bytes	512 Bytes	4 KB
Clock Speed	16 MHz	8 or 16 MHz	16 MHz	8 MHz	8 MHz	16 MHz	16 MHz	16 MHz

Ref: <http://www.robotshop.com/arduino-microcontroller-comparison.html>

Microcontroller Board Selection:

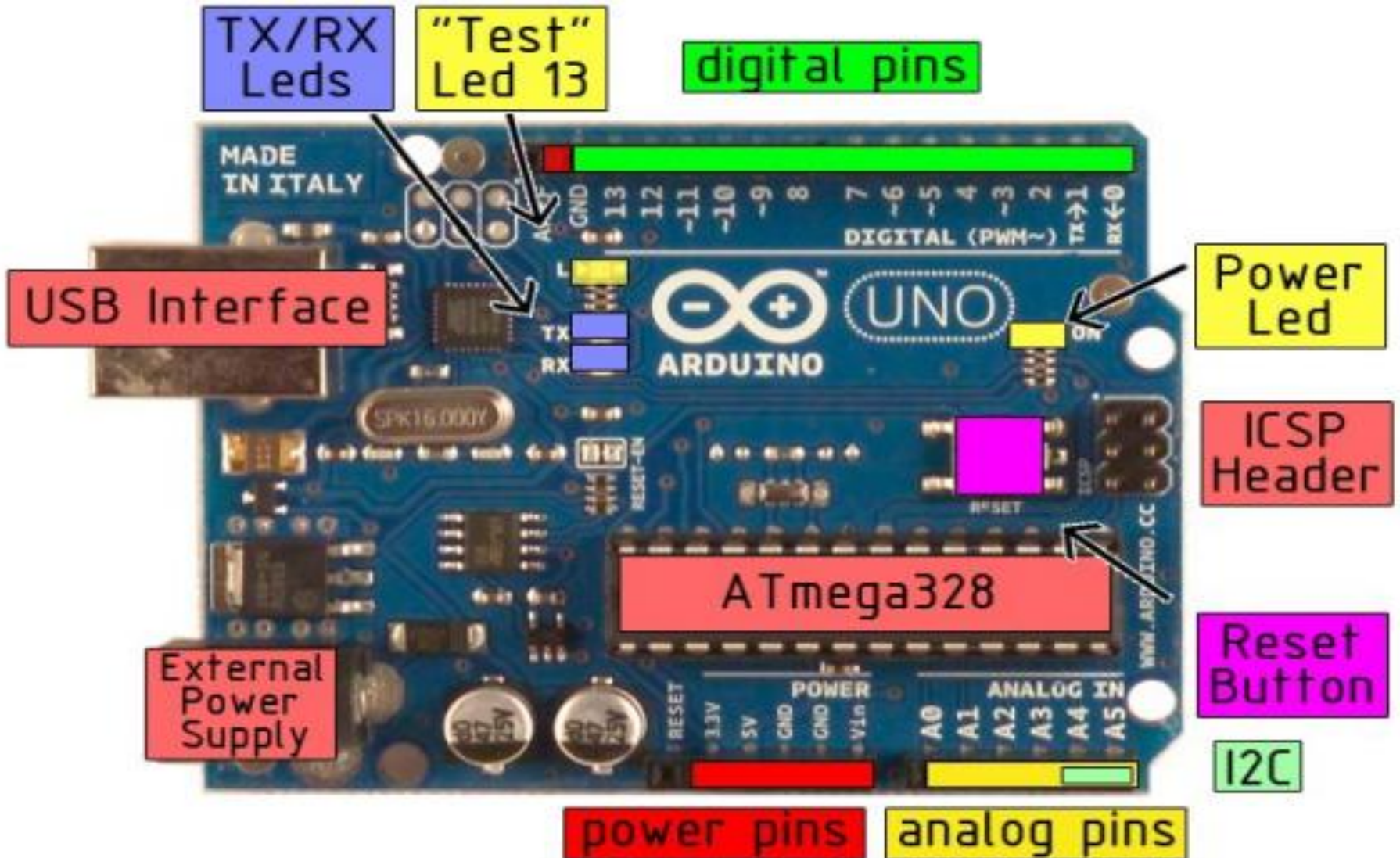
The selection guide for using the suitable microcontroller board includes:

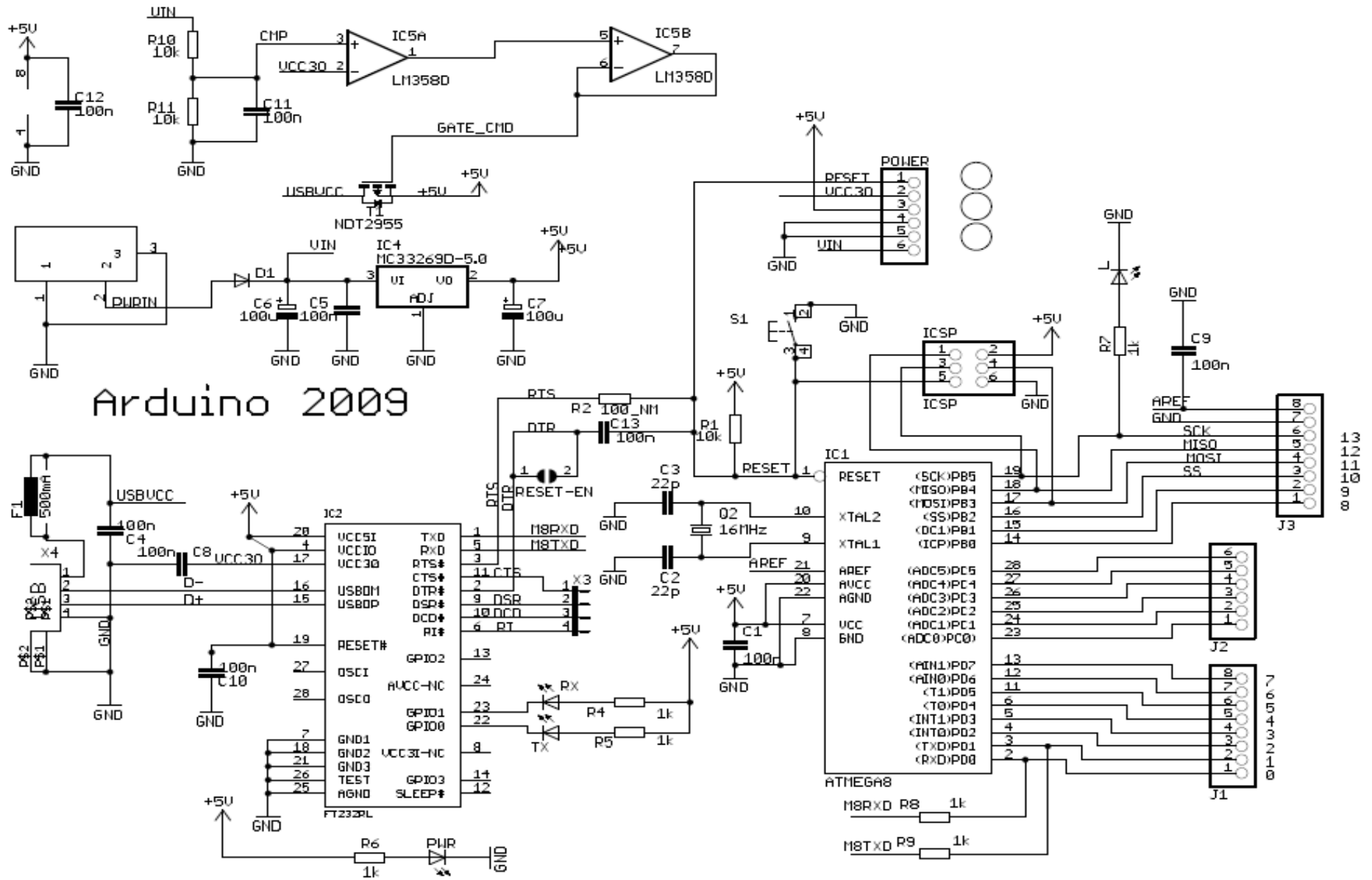
1. Meeting the hardware needs for the project design;
 - number of digital and analog i/o lines.
 - size of flash memory, RAM, and EPROM.
 - power consumption.
 - clock speed.
 - communication with other devices.
2. Availability of software development tools required to design and test the proposed prototype.
3. Availability of the microcontroller board.

•According to the board selection criteria, you can choose the suitable microcontroller board for your design such that all sensors and actuators are connected to the available input/output lines. The following table shows comparison between the Arduino microcontrollers.

Specifications	Arduino Mini Light	Arduino UNO	Arduino Bluetooth	Arduino MEGA
Microcontroller	ATmega 168	ATmega 328	ATmega 168	ATmega 1280
Operating Voltage	5 V	5 V	5 V	5 V
Input Voltage	7-9 V	7-12 V	1.2-5.5 V	7-12 V
Digital I/O Pins	14	14	14	54
Analog I/P Pins	8	8	8	16
DC Current per I/O Pin	40 mA	40 mA	40 mA	40 mA
Flash Memory	16 KB	32 KB	16 KB	128 KB
SRAM	1 KB	2 KB	1 KB	8 KB
EEPROM	512 Bytes	1 KB	512 Bytes	4 KB
Clock Speed	16 MHz	16 MHz	16 MHz	16 MHz

The Arduino Uno board:

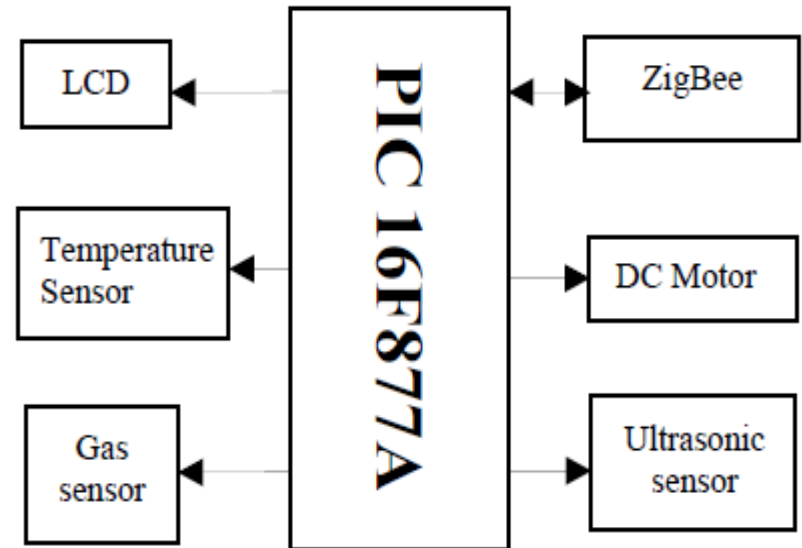
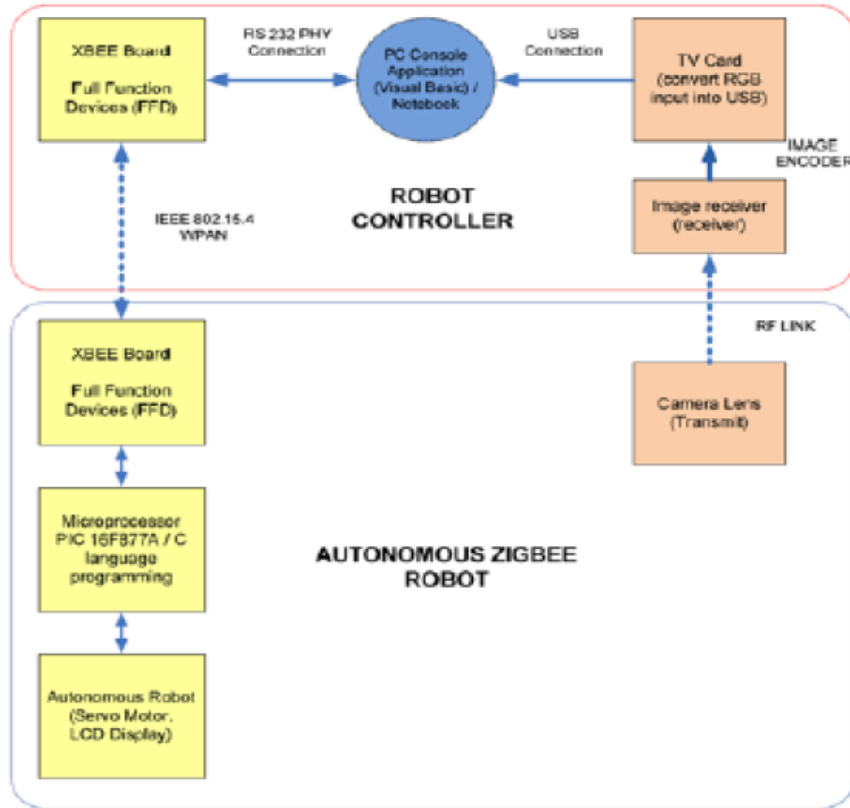




The Arduino Uno Board has the following specifications:

- It is a small size board, (6.9 cm * 5.3 cm) board.
- 14 digital input/output pins, 6 of them can be used as PWM outputs.
- 6 analog inputs (with 10-bit ADC) to deal with analog input signals.
- 32 KB flash memory, 2KB SRAM, and 1 KB EPROM.
- 16 MHz ceramic resonator.
- USB connection for interfacing with other units.
- It can be powered via the USB connection or with an external power supply (an AC-to-DC adapter or battery).
- Each input/output pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor.
- It has some pins have specialized functions such as serial interfacing, and external interrupts.
- It has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers.
- It has a resettable fuse that protects computer's USB ports from shorts and over current.

Example: Mobile Robot control using Zigbee Technology

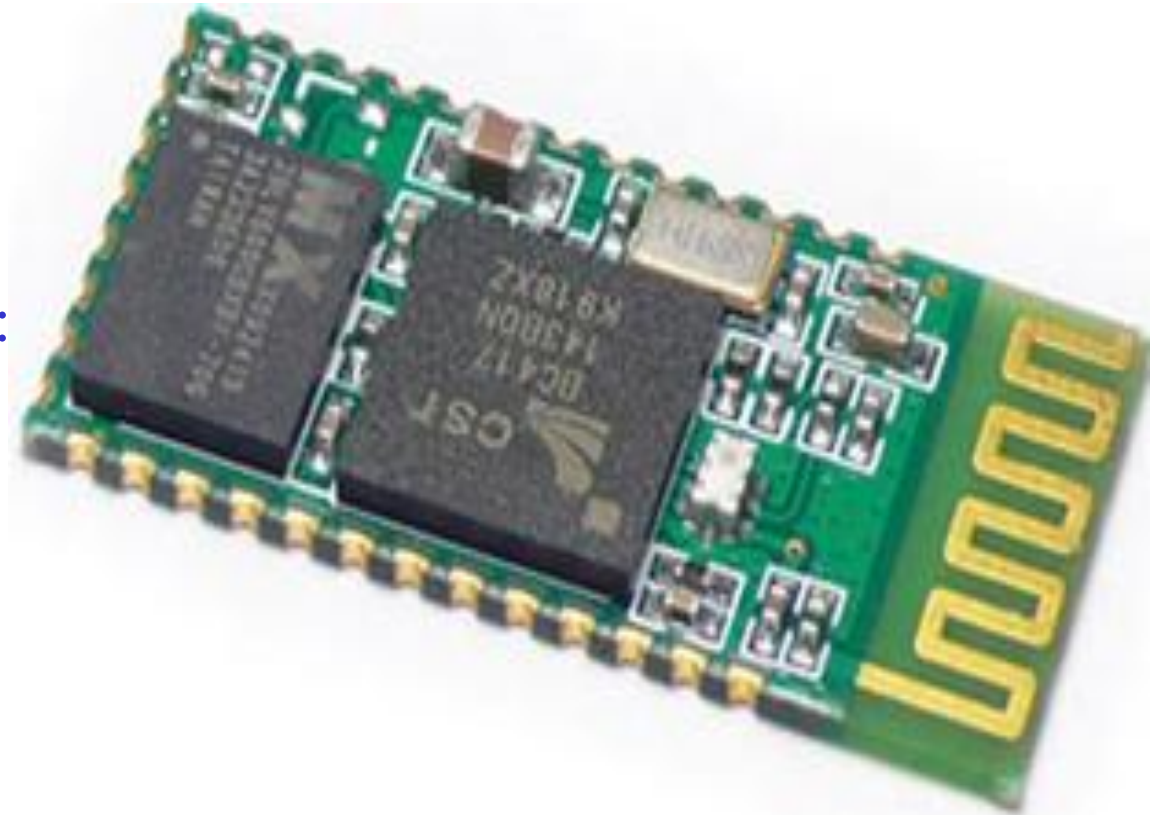


Wireless Communications With Arduino Uno Board:

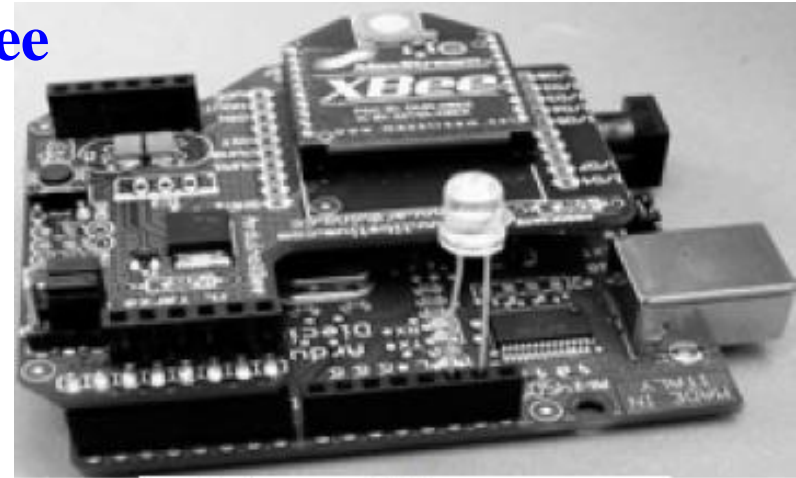
The wireless communications channel between the Arduino Uno Board and another board or the internet can be achieved using:

- The Bluetooth adapter.
- The ZigBee adapter.
- The WiFi adapter.

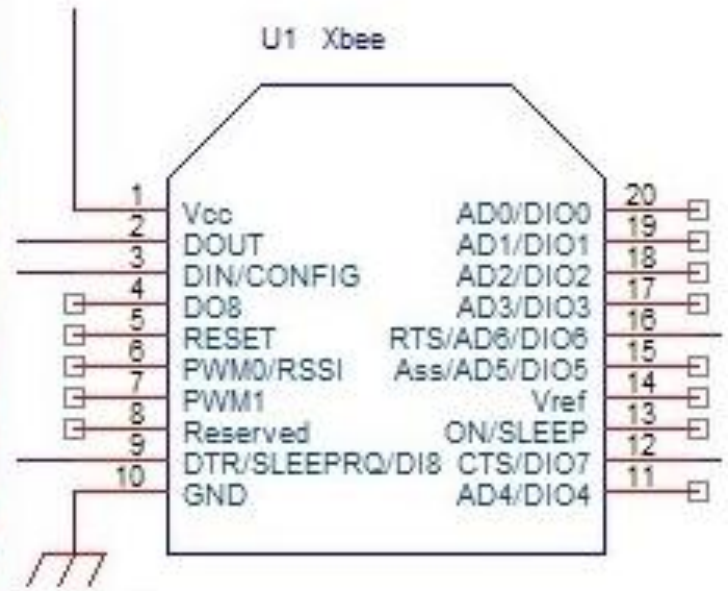
The Bluetooth Adapter:



Single-Board Microcontroller + ZigBee

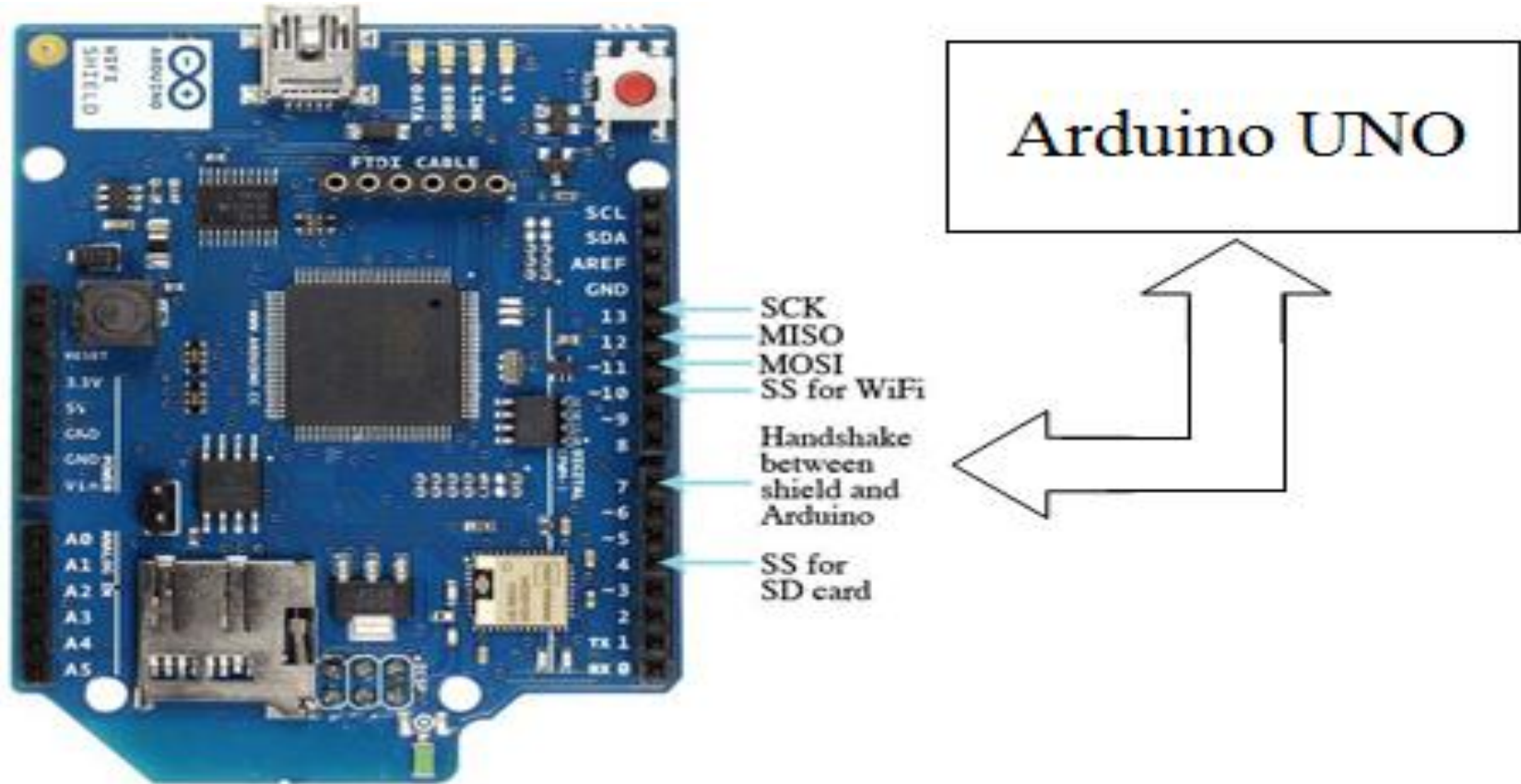


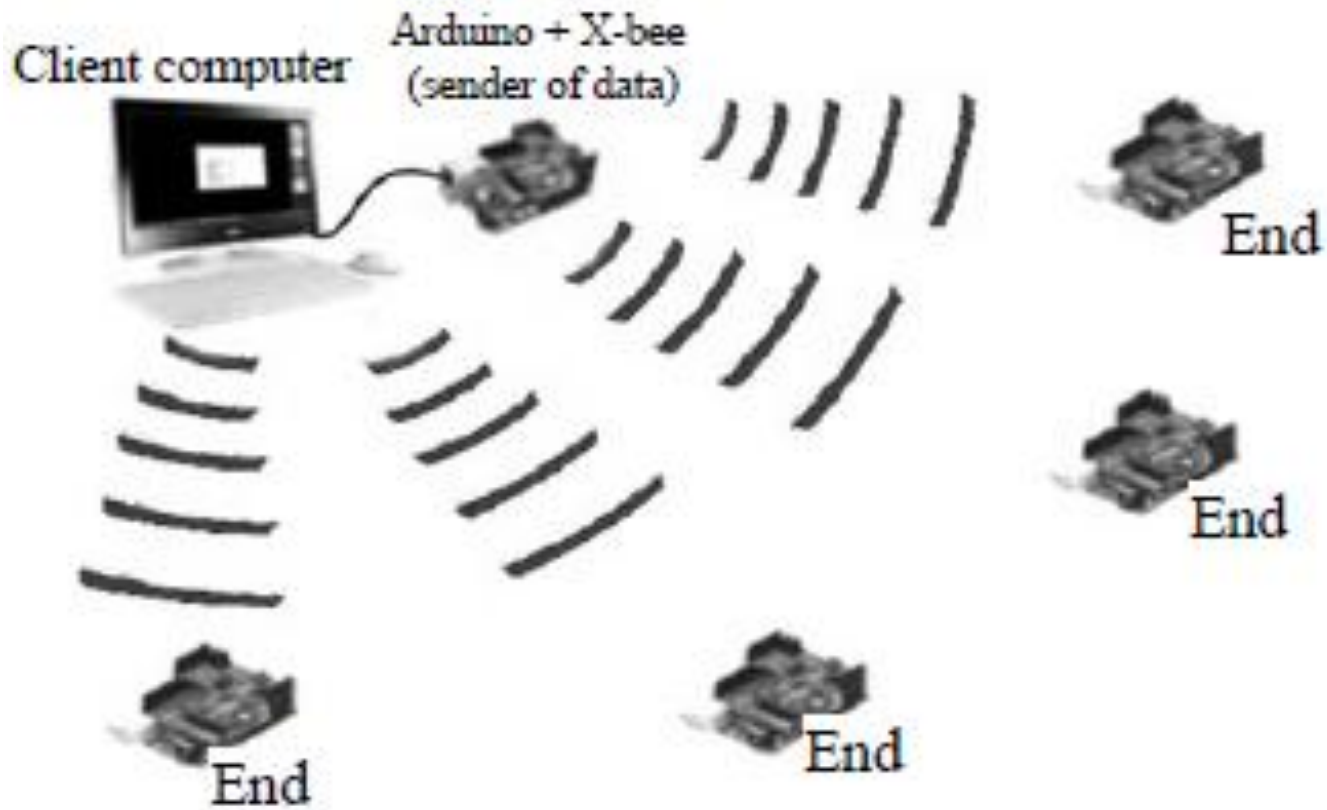
Arduino + X-bee.



The WiFi Shield:

The WiFi Shield can be mounted on the top of the Arduino UNO board using SPI port. Only six lines from the microcontroller board are required for WiFi interfacing. Depending on the wireless router configuration, the microcontroller will set up the WiFi shield to see the selected network.





References:

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6. <http://arduino.cc/en/Main/arduinoBoardUno>
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