

Pervasive or Ubiquitous computing

1.1 Examples of Pervasive Computing

1.2 Pervasive Computing Technology

1.3 The Computer for the 21st Century

2.1 Current Ideas (what many see as predictions of the future of computing)

2.2 The Internet of Things (IoT)

3.1

The general idea is that computing is moving from a "centralized" to a "distributed" environment where computing is made to appear "anywhere" and "everywhere".
The general idea is that **computing disappears into the environment and becomes a "natural part" of our surroundings with a seamless user interface**.

Characteristics of Pervasive Computing

- Embedded: networked devices integrated into the environment
- Context aware: these devices can recognize you and your environment and react to them
- Adaptive: they can change in response to your environment and become a "natural part" of our surroundings with a seamless user interface
- Natural user interface (nun): voice, gestures

A lamp in your lounge room that usually behaves normally but will change colour if it needs to convey some information. For example, want or bad weather, to remind you to take some medication.

Usually refers to a normal everyday device that has been enhanced to interact in some way

Example of ambient information display:

A lamp in your lounge room that usually behaves normally but will change colour if it needs to convey some information. For example, want or bad weather, to remind you to take some medication.

Automated lighting/heating systems in modern buildings.

More examples?

Mobile phones, machines, home automation, voice assistants (amazon, google etc)

Networks: hardware/software/protocols, wifi, bluetooth, mobile networks, NFC, etc...

Packaging: materials, 3D printing, design...

Describes Research at Xerox PARC into new computing devices and form factors

PARC was where Ethernet, the networking technology used everywhere today was invented

Suggests that the future is not just "personal devices but computers that vanish into their background". Always available.

People will simply use them unconsciously to accomplish everyday tasks."

How Xerox PARC into new computing devices and form factors

described the experience of the prime phone, tablet, web as interactive displays

or hardware: microcontrollers, small systems, cloud

Sensors and actuators: digital/analogical, wearable

Interfaces: parallel, serial, media

Software: operating systems, IDEs, cloud based dev environments, platforms

Networks: hardware/software/protocols, wifi, bluetooth, mobile networks, NFC, etc...

Packaging: materials, 3D printing, design...

Hardware: microcontrollers, small systems, cloud

Or hardware: microcontrollers, small systems, cloud

• Consumer
- smart homes,
- environmental control,
- lighting security,
- health care; monitoring,
- medication management,
- transport; ride share,
- service location

• Industrial
- factory monitoring and
control
- industrial
control
- smart cities

• Government
- agricultural
- crop monitoring
- paddock to the plate
- tracking

• Research
- IoT objects
- industrial
- medical
- environmental
- space

• Internet of Small Devices, Industrial Communications,

• Application Layer Protocols

- MQTT is available for many platforms and languages (C/C++, Java, Python, javascript, node.js)

- MQTT has the message type (topic) and parameters

- Some Pub/Sub systems use MQTT to carry messages, while others use HTTP, AMQP, JMS, MQTT, DDS, etc.

- Many for web content, but now used for others

- A simple and lightweight Pub/Sub protocol

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Question 1 Multiple Choice

- When powering an LED, a series resistor must be carefully chosen so that:
 - You do not overdraw current
- Why do we call Mark Weiser's The Computer for the 21st Century a seminal paper?
 - It has impacted so many other research fields
 - It defined the field Ubiquitous/Pervasive Computing
- With respect to the basic structure for IoT, please select statement(s) that are correct.
 - Connections between IoT objects are part of the network.
 - Edge computing creates a distributed system.

Question 2 Evaluation

You have developed a mobile app that displays the step count of users using a wearable sensor.

- Write an abstract task.
Determine step count using the app
- Write two concrete tasks.

- Determine the number of steps walked in the past hour
- Determine the number of steps walked in the past day
- Determine the number of steps walked in the past week
- Determine the number of steps walked in the past month

Question 3 Interfaces

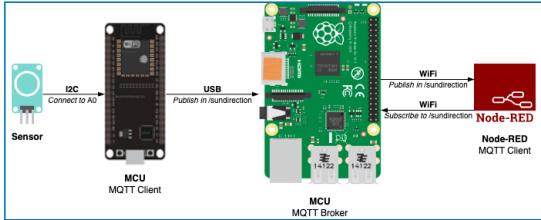
Consider the interface available in a Virtual Reality Environment.

- Which interaction style best describes this interface?
Exploring
- Briefly explain why it describes it the best.
It involves a user moving through a virtual space, similar to how we explore physical spaces.

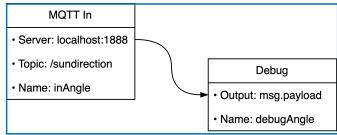
Question 4 Pervasive Application

A simple pervasive system is needed to measure the direction of the sun to control a solar panel.

- Draw a block diagram of how the four (4) components of the system are interconnected.



- Sketch a Node-RED flow for the above application.



Quiz 1

- With respect to the basic structure for IoT, select all the correct statements.
 - Connections between IoT objects are part of the network.
 - Edge computing creates a distributed system.
- With respect to the management system of IoT select all the correct statements
 - IFTTT is a good method for end-user programming because it is easy to code with.
 - A change that applies to many IoT objects can be centrally controlled.
- In crop monitoring, IoT can be used to:
 - Monitor crop health using drones.
 - Connect sensors on the farm to monitor plant growth.

Quiz 2

- A student wrote the following program for a FireBeetle ESP32-E. It must read an analog sensor (Amplitude range: 0 to 3.3V, Frequency bandwidth: 25Hz, Connection: A4) and send the values through the COM port to a computer separated from a new line. Before sending, the value should be mapped from 0 to 100. Fix three errors in the code below.

```
1 int lightSensor = 0;
2 int lightPin = A0;
3 void setup() {
4     Serial.begin(9600);
5     analogReadResolution(8);
6 }
7 void loop() {
8     lightSensor = analogRead(lightPin);
9     lightSensor = map(lightPin, 0, 1024, 0, 100);
10    Serial.println(lightSensor);
11    delay(18);
11 }
```

- Line 3 lightPin should be A4
- Line 4 pinMode(lightPin, INPUT); is missing
- Line 13 lightPin should be lightSensor.
- Line 13 Should be lightSensor = map(lightSensor, 0, 255, 0, 100);

Quiz 3

- Which of the following communication method(s) can create a network connecting five peripheral devices (e.g. sensors) with a control device (MCU) using star topology?
 - Bluetooth
- For an application that needs scalability of adding new devices to a network(s), which networks are the best choices.
 - WiFi
- You must choose a wireless network that collects data from farm animals (75m radius). There are 100 animals with sensors, each needs communication speed of 3Kbps (20% communicate at a time). MCU is at the edge of the farm. Which network is best?
 - LoRa

Quiz 4

- When using an analog sensor with ADC, a series resistor must be carefully chosen to:
 - Minimise the amount of current used
- You aim to use the below sensor with a microcontroller that operates at 12MHz and 1.8V operating voltage. Select the true statement(s).

Features	
Photodiode NDIR sensor technology PAsens®	High accuracy: +/- 5 ppm
Smallest form factor: 10.1 x 6.5 mm²	Digital I2C interface
Reflow solderable for cost effective assembly	Integrated temperature and humidity sensor
Large output range: 0 ppm - 40'000 ppm	Low power operation down to < 0.4 mA avg.
Large supply voltage range: 2.4 - 5.5 V	@ 5 V, 1 meas./ 5 minutes

- Will not work

- Write an Arduino program for the micro-controllers that read the sun direction from the sensor and post them to a topic in the MQTT broker.

```
1 #include <WiFi.h>
2 #include <MQTT.h>
3
4 IPAddress mqttHost(172, 23, 31, 4);
5 WiFiClient wifiNet;
6 MQTTClient mqttClient;
7
8 // WiFi settings
9 const char ssid[] = "solarWiFi";
10 const char pass[] = "soalar2023";
11
12 void messageReceived(String &topic, String &payload);
13
14 unsigned long lastTime = 0;
15 int outReadingInt;
16 char outReadingStr[5];
17 int inReadingInt;
18
19 void setup() {
20     Serial.begin(115200);
21     analogReadResolution(8);
22     pinMode(A0, INPUT);
23
24     Serial.println("Connecting to WiFi:");
25     Serial.print(ssid);
26     WiFi.begin(ssid, pass);
27
28     while (WiFi.status() != WL_CONNECTED) {
29         delay(500);
30     }
31     Serial.println(WiFi.localIP());
32
33     mqttClient.begin(mqttHost, 1888, wifiNet);
34     while (!mqttClient.connect("esp32-mqttClient")) {
35         delay(500);
36     }
37     Serial.println("\nMQTT connected!\n");
38     mqttClient.subscribe("/sundirection");
39 }
40
41 void loop() {
42     mqttClient.loop();
43     outReadingInt = analogRead(A0);
44     outReadingInt = map(outReadingInt, 0, 1023, 0, 180);
45     itoa(outReadingInt, outReadingStr, 5);
46     // Publish a message roughly every 10 seconds
47     if (millis() - lastTime > 10000) {
48         lastTime = millis();
49         mqttClient.publish("/sundirection", outReadingStr);
50     }
51 }
```

- The figure shows a circuit designed to drive a motor through a transistor using PWM. Where should be the PWM trigger connected to?
 - Tb

Quiz 5

- You want to connect Node-RED to MQTT broker hosted at server "mqtt.random.com", port 1883. Your node-red instance is running at "localhost". Which of the following settings must you set in the MQTT connection settings?
 - Set "Port" to 1883
 - Set "Server" to "mqtt.random.com"
- Which of the following node(s) are necessary to publish to an MQTT broker. ~1min
 - MQTT IN and MQTT OUT
- You are to read sensor data from the MQTT broker "mqtt.broker.org". The topics are organised first by country, then by state, and finally the sensor-type. The broker has following topics and subtopics.
 - Countries: au, us
 - States under AU: nsw, qld, vic
 - States under US: ca, ny, nm
 - Sensor-types under all states: tmp, humWhat is the topic string you set to subscribe to humidity in California, United States? /us/ca/hum

Quiz 7

- You are asked to characterise a digital wearable sensor that measures the elbow angle of the wearer. Your goal is to validate that it has an angular resolution of +/- 4 degrees. Select the possible state of the art choice(s) to validate your sensor. (1.30 min)
 - An analog elbow angle sensor with +/- 1 degrees
 - A digital elbow angle sensor with +/- 1 degrees
- You developed a mobile app that tracks your sleeping habits. The app shows the sleep time and quality for last night, along with average, min/max sleeping time and quality organised into daily, weekly, monthly, or even hourly. Write two (2) concrete tasks.
 - Find out the sleep quality for last night
 - Find out the sleep time for last night

Quiz 9

- You must make a casing for a device to measure sunlight. It needs to be black and should be a box. Make the casing as soon as possible. Which approach is best?
 - Laser cutting
- Consider the interface available in am Virtual Reality environment. Which interaction style best describes this interface?
 - Exploring
- Select contexts that could cause a Situationally-Induced Impairments and Disability.
 - Getting closer to a deadline
 - Working in a construction site

Quiz 10

- CS pin in the Serial Peripheral Interface (SPI) is used to.
 - Select the peripheral interface the controller is communicating with
- An ADC operates with input range 0 to 5V, with bit resolution 10 bits. If a voltage of 1.65V is given as the input, what will be the approximate output from analogRead()?

$$\text{ADC Output} = \left(\frac{\text{Input Voltage}}{\text{Reference Voltage}} \right) \times \text{Maximum ADC Value}$$

$$\text{ADC Output} = \left(\frac{1.65V}{5V} \right) \times (2^{10} - 1)$$

ADC Output ≈ 337