

TUNKU ABDUL RAHMAN UNIVERSITY OF MANAGEMENT AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATION TECHNOLOGY

ACADEMIC YEAR 2024/2025

OCTOBER EXAMINATION

BAIT2123 INTERNET OF THINGS

MONDAY, 21 OCTOBER 2024

TIME: 2.00 PM – 4.00 PM (2 HOURS)

BACHELOR OF COMPUTER SCIENCE (HONOURS) IN DATA SCIENCE

BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN INFORMATION SECURITY

BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN INTERNET TECHNOLOGY

BACHELOR OF INFORMATION TECHNOLOGY (HONOURS) IN SOFTWARE SYSTEMS

DEVELOPMENT

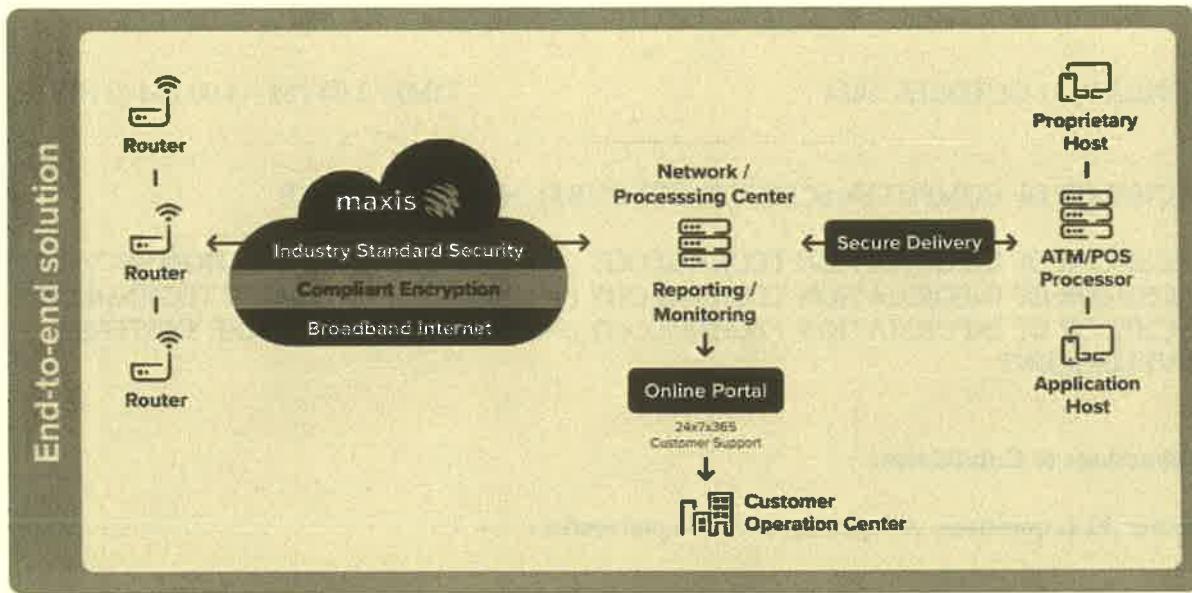
Instructions to Candidates:

Answer **ALL** questions. All questions carry equal marks.

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Question 1

The Internet Service Provider, i.e., Maxis offers a one-stop IoT network solution for designing, building and managing a secure network to give customers peace of mind so that customers can focus on their financial service businesses.



The solution above provides complete onboarding and 24/7 dedicated support with prompt updates upon service disturbance and monthly uptime reporting. For instance, the Automated Teller Machine (ATM) that lets customers withdraw cash from their bank account without visiting a teller / counter service, or the Point of Sales (POS) terminal kiosk payment system / vending machines let customers select their favourite items from the racks and pay via e-Wallet services.

Source:

Managed IOT network solution: IOT business solutions. Maxis Business. (2024, July).
<https://www.business.maxis.com.my/en/iot/managed-iot-network-solution/>

- a) Illustrate how the ATM / POS terminal can be an Internet of Things (IoT), based on the 3 elements that every IoT should have. (6 marks)
- b) State and describe the communication model that is suitable to run the ATM / POS terminal features. (4 marks)
- c) In a modern IoT platform architecture, provide **TWO (2)** architectural components. (2 marks)
- d) Besides the predictive maintenance features, based on the answer in Question 1 c), describe how these **TWO (2)** architectural components are utilised in this financial service business. (4 marks)
- e) State and describe **TWO (2)** new resources or activities that are created by implementing IoT solutions in this financial service business. (6 marks)
- f) Relate **ONE (1)** emotional benefit and describe it based on this financial service business scenario. (3 marks)

[Total: 25 marks]

Question 1 a)

- Identity

↳ ATM or POS terminal has its unique MAC address and serial number for being recognized, authenticated or addressed individually.

- Intelligence

↳ ATM or POS terminal will use the microcontroller logic to calculate and give out the specific amount of money based on users' entered amount, or take out the specific items based on what items have been ordered by customers.

- Communication

↳ ATM or POS terminal will communicate with its respective cloud service or payment gateway via wired Ethernet connection for storing all transaction records or completing payment transaction.

Question 1 b)

- Device-to-cloud communication model

- The ATM / POS terminal directly connect to Internet cloud service using wired Ethernet connection so it can upload all the transaction history or any log messages to the cloud storage without going through an intermediary application server.

Question 1 c)

- Database

- External interfaces

Question 1 d)

- Database

- ↳ A scalable hybrid cloud-storage enables the financial service business to store large amount of transaction records and event data to the cloud storage.
- ↳ So, the operators or administrators can easily access and check with the transaction history remotely through cloud storage.

- External interfaces

- ↳ Financial service business can integrate with other applications such as payment gateway and e-Wallet service API (Application Program Interface) to help to complete money transactions in physical or cashless form.

Question 1 e)

- Unique data sets

- ↳ The machine is able to collect & hold of large IoT data sets to build up a position not reachable by competitors.
- ↳ For example, the ATM / POS terminal can collects the data of when the most users access to the service, so it can adjust the machine operation hours automatically based on the data of users' behavior to maximize the efficiency and productivity of the machine.

- Exclusive co-operation and contracts

- ↳ Cooperation with other companies may strategically lock-out other competitors.
- ↳ For example, the ATM / POS terminal can cooperate with other shopping malls or office buildings so they can be placed at the location where having the most people to access the services. More people will recognize the machine and utilize the service provided by the ATM / POS terminal.

Question 1 f)

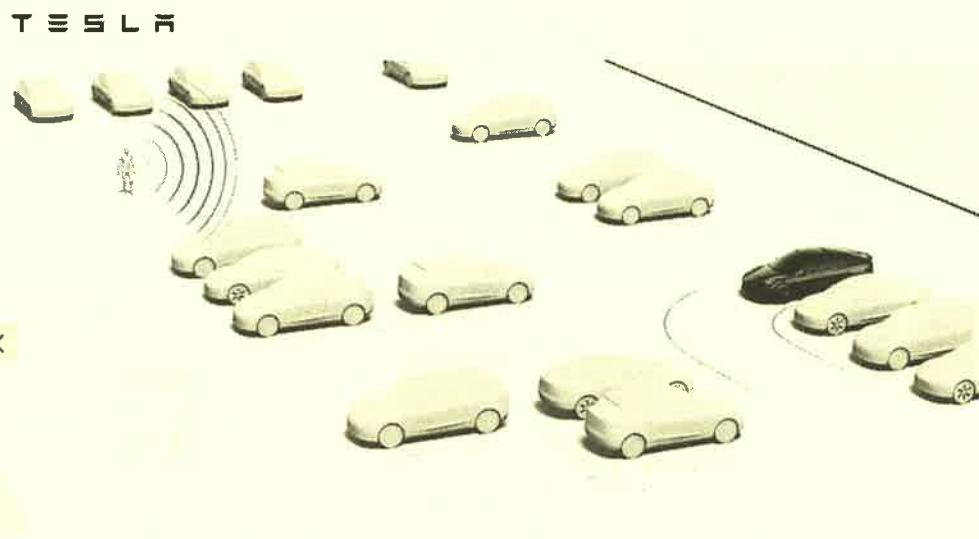
Confidence

- ↳ Since the ATM/POS terminal has come with cashless payment integrated with secure payment gateway via Ethernet connection, the customers would feel confident while using the service.
- ↳ They do not need to worry about their money being stolen when using the machine.

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Question 2

- a) Tesla is a leading electric car manufacturer known for its innovative technology and advanced features. One such feature is Summon, a semi-autonomous capability that allows Tesla owners to move their vehicle in and out of tight parking spaces or garages remotely, using their smartphone or key fob. This adds convenience, especially in crowded parking lots or narrow driveways.



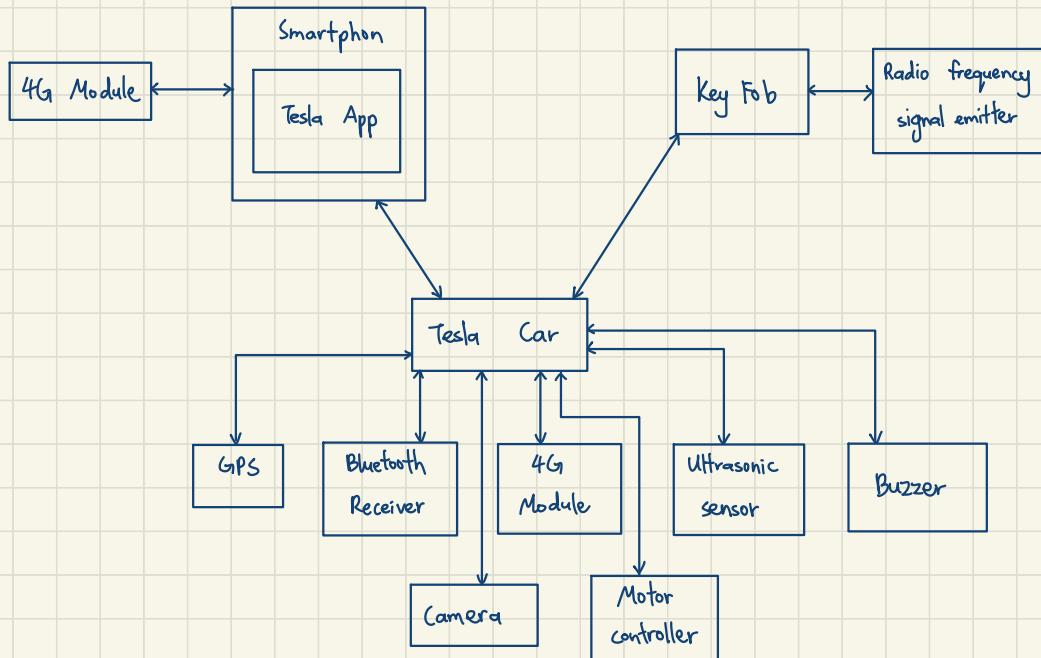
Source:

Design your model 3. Tesla. (2024, July).
https://www.tesla.com/en_my/model3/design#overview

- (i) Draw a block diagram (with data flow direction) and describe how the Tesla car owner enables moving the car forward and backward in a straight line for short distances and avoiding obstacles, with the IoT implementation. (8 marks)
- (ii) Provide **TWO (2)** advantages of how the smart car solution helps in escalating an ordinary city development into a smart city. (6 marks)
- b) In IoT Stacks, the X layer includes the flow and task placement to keep track of the state of available cloud and network resources to identify the best candidates to hold incoming tasks and flows for execution.
- (i) Identify the name of the X layer. (2 marks)
- (ii) From the scenario in **Question 2 a)**, illustrate **ONE (1)** use case of the flow and task placement execution in the smart car solution. (3 marks)
- (iii) Besides the flow and task placement, state **THREE (3)** other features of the X layer that work as software-defined resource management. (6 marks)

[Total: 25 marks]

Question 2 a) (i)



Question 2 a) (ii)

- Efficiency improvement

- ↳ The smart car solution provides the smart and automated car moving in or out of parking space, so users no need to manually find the parking space which is spending a lot of time.
 - ↳ The car owner can just leave the car and go into the place he want, then let the car to automatically find a great place to park.

- Security

- ↳ The smart car solution can also provide better security when parking. The car has a lot of built-in sensors and precise AI algorithm which can help the car owner to accurately move the car into the parking spaces.
 - ↳ Human may easily make mistakes or wrong decision when parking, especially when dealing with the tight parking spaces. They may accidentally crash their cars with the wall when moving the cars into parking space.
 - ↳ If using automated and well-trained AI algorithm, the controller can precisely compute the distance between car and the obstacles and predict how much acceleration to be taken to securely park the car into the space.

Question 2 b)

(i) Analytic platform layer

- (ii) - When the car is in idle state (car is in the parking space), more available cloud and network resource will be put into the bluetooth receiver or Wi-Fi or cellular network module for receiving any action signals at surrounding.
- When the car owner uses his smartphone's Tesla App to send signal to the car for moving out of the parking space, more resources will be put into the auto-pilot module, camera, ultrasonic sensors and motor controllers to enable the car to detect surrounding condition and securely move out of the parking space.

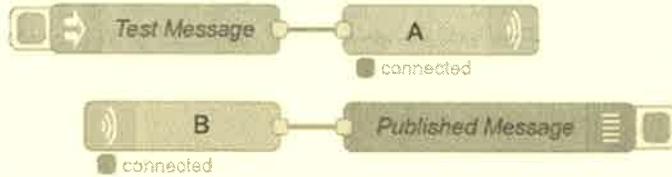
(iii) - Knowledge base

- ↳ It stores the past data about the app and resource usage.
- ↳ It allows other services to make smarter decisions using historical trends.
- Performance prediction
 - ↳ It uses historical data to predict how cloud resources will perform.
 - ↳ It helps Resource Provisioning decide how many resources are needed during high load or poor performance.
- Monitoring and profiling
 - ↳ It continuously monitors system and app performance.
 - ↳ It creates detailed profiles of resources and applications for better insight and optimization.

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Question 3

- a) Under the Node-RED palette, there is a pair of MQTT nodes: one for naming the node and the other for indicating whether it will broadcast (publish) or receive (subscribe to) messages.



- (i) Provide **THREE (3)** essential configurations required for establishing data communication using MQTT protocol. (6 marks)
- (ii) Label A and B with the correct action (actor name) in the MQTT protocol. (2 marks)

- b) The following Python codes illustrate the procedure for RFID card reading and buzzer output

Line	Code
01	import RPi.GPIO as GPIO
02	from mfrc522 import SimpleMFRC522
03	from gpiozero import LED
04	import time
05	buzzer = LED(18)
06	reader = SimpleMFRC522()
07	try:
08	while True:
09	print("Place your tag")
10	iden, text = reader.read()
11	print(iden, " ", text)
12	if str(iden) == "1042104857385":
13	print("Boleh Masuk")
14	buzzer.on()
15	time.sleep(0.08)
16	buzzer.off()
17	time.sleep(0.08)
18	buzzer.on()
19	time.sleep(0.08)
20	buzzer.off()
21	else:
22	buzzer.on()
23	time.sleep(1)
24	buzzcr.off()
25	except KeyboardInterrupt:
26	print("Program ended")
27	finally:
28	buzzer.off()
29	GPIO.cleanup()

- (i) Identify the **full name** of the protocol used by the MFRC522 module. (3 marks)
- (ii) List and describe **TWO (2)** basic required hardware connections for data communication, using the protocol in Question 3 b) (i). (4 marks)
- (iii) Illustrate the result/impact of removing code line 10. (2 marks)
- (iv) Illustrate the purpose of line 22 to 24, and the possible physical action to be executed. (2 + 2 marks)
- (v) In line 28, why is it important to include *buzzer.off()* ? (4 marks)

[Total: 25 marks]

Question 3 a)

(i) - Broker IP Address

- ↳ It is the address of MQTT broker or server that handles message routing between publishers and subscribers.
- ↳ All client must connect to the same broker to exchange messages.

- MQTT topic

- ↳ It defines the "channel" for publishing and subscribing messages.

- Port number

- ↳ It is the TCP port on which the broker listens for MQTT connections.

(ii) - Label A : mqtt out

- Label B : mqtt in

Question 3 b)

(i) Universal Asynchronous Receiver Transmitter (UART)

(ii) - RX (Receive)

↳ This pin is used to receive serial data from the Raspberry Pi or any other microcontroller.

- TX (Transmit)

↳ This pin is used to send serial data to the Raspberry Pi or any other microcontroller.

(iii) The RFID card will not be able to read

(iv) - At line 22, it turns the buzzer on.

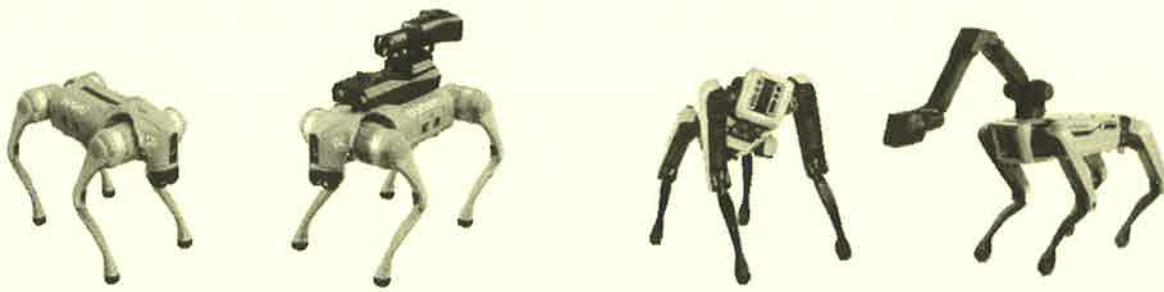
- At line 24, it turns the buzzer off.

- The possible physical action to be executed is the buzzer will produce sound when turned on. After 1 second, it stops producing the sound because it is turned off.

(v) - It can ensure that the buzzer will always be turned off after running the previous code no matter the exception is triggered or not.

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Question 4



Left: Go2 by Unitree (2024), \$2,700

Right: Spot by Boston Dynamics (2024), \$74,500

Source: Robot Dog Go2 - Intelligent New Species - UniTree. (2024, July). <https://www.unitree.com/go2/>
Home | Boston Dynamics. (2024, June 28). Boston Dynamics. <https://bostondynamics.com/>

Robot dogs, also known as quadruped robots, are four-legged IoT devices designed to mimic the movements and behaviours of dogs. The two popular robot dogs: Unitree Go2 and Boston Dynamics Spot offer a versatile platform for various applications, from research and education to industrial tasks and entertainment.

The Unitree Go2 is a sleek, agile quadruped robot designed with consumers in mind. Its affordability and open-source software make it a popular choice for students, researchers, and hobbyists seeking to learn about robotics or customise their own robot companion. While not designed for heavy-duty tasks, it excels at agile movements like walking, trotting, and running, even performing basic tricks. Its light weight and compact size make it ideal for educational settings and personal use.

In contrast, the Boston Dynamics Spot is a rugged and robust quadruped built for industrial applications. It boasts advanced mobility, navigating complex terrains and carrying heavy payloads of up to 14kg. This modular platform can be equipped with various sensors and tools, making it suitable for inspections, data collection, and hazardous tasks in challenging environments. Its autonomous navigation capabilities further enhance its value for commercial and industrial users seeking reliable and efficient robotic solutions. However, its high price point limits its accessibility to consumers.

- a) Discuss feasibility studies by analysing the *general market opportunity* and *time / channel to market* for using these robot dogs. (6 marks)
- b) Sketch a robot dog solution using the Usage Viewpoint in the Industry IoT Consortium Reference Architecture (IIC RA). Your solution should include *User Interfaces*, *Processes*, *Rules*, *Data*, and relevant stakeholders. (8 marks)
- c) Relate TWO (2) use cases based on the robot dog solution. (6 marks)
- d) Illustrate the issue of *incorporated intelligence* that could occur while using the robot dog in the manufacturing industry. (5 marks)

[Total: 25 marks]

Question 4 a)

General market opportunity

- ↳ There are a lot of universities, educational campaigns and programs would require the robot dogs for teaching the students who are in robotic-related courses.
- ↳ This can help to stimulate students' learning interests and learn the structure and code implementation on the robot dogs.
- ↳ Thus, this is the best opportunity to present the robot dogs in the market.

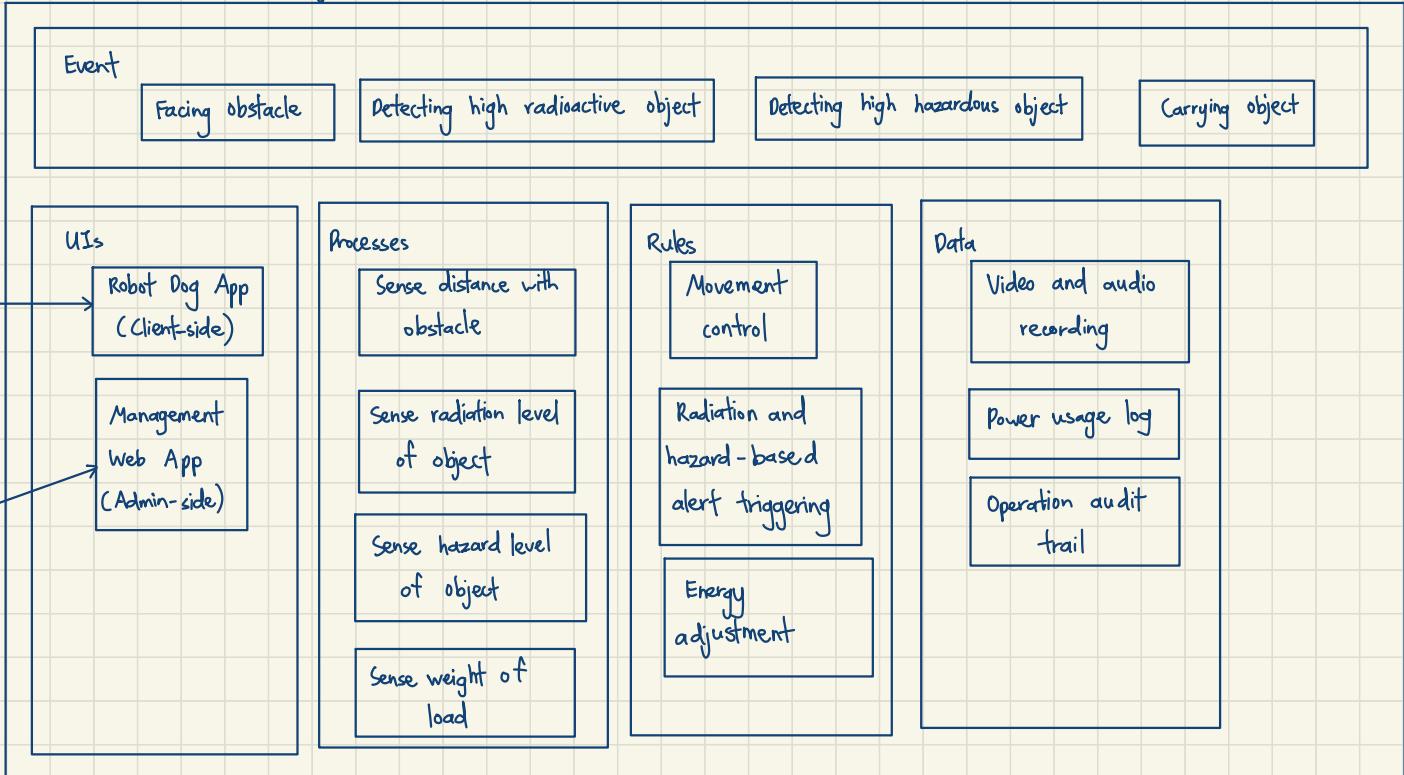
Time / channel to market

- ↳ The seller of robot dogs can partner with educational distributors and directly target robotics program at universities and technical schools.
- ↳ The seller can also leverage online platforms and maker communities for the consumer segment, with demonstration videos and educational content to build market awareness and technical confidence.

Question 4 b)



Robot dog
↓



Question 4 c)

- Robot dog can be used as a patroller to monitor and detect any threat around the military areas. When there are any attacker or suspicious behavior detected by the robot dog, it will immediately trigger alerts to safety officers when logging GPS coordinates.
- During hazardous chemical spills, the robot dog can assesses the contamination zones while maintaining minimum safe distances based on chemical sensor readings. It helps to map contamination boundaries and collect samples when safe, adjusting its movement to accommodate carried objects.

Question 4 d)

- Robot dogs may sometimes misinterpret the complex manufacturing environment and operators' behavior.
- For example, robot dogs observe workers clustered around machinery during shift change
- It interprets this as "unusual activity" or potential security threat. Thus, it triggers the unnecessary alerts and cause operation disruption.
- However, this is actually the normal shift handover procedure, with safety briefings only.