AQA Computer Science A-Level

4.7.4 External hardware devices

Past Paper Mark Schemes

Additional Specimen Paper 2

05	3	**All marks AO1 (understanding)**	3

SSD	**Hard Disk**
Lower power consumption	Lower cost per MB/GB // greater capacity for same price **N.E.** cheaper
Faster read/write (access) times	Higher capacity drives available
No delay whilst disk spins up to speed // lower latency	Have been used for a long time so greater confidence about storing data for long term // less concern about number of write cycles that can take place
Noiseless operation **A.** quieter	
Less heat generated // No additional cooling/fan required	
Less vulnerable to damage from physical impact / magnetism	

		Award **1 mark per valid point made** from the table above about each type of storage device. To award the mark, the point **must be explicitly related to the application** eg "lower power consumption" by itself would not be worth a mark, but "lower power consumption which is important as the NAS will probably be switched on all day" would be. Points can be awarded for both devices, but **MAX 2 if only one type of device is referred to**.	

05	4	**All marks AO1 (recall)** (Most commonly) uses NAND flash memory; Data stored using floating gate transistors; This is a type of transistor that can trap and store charge // does not lose state when power no longer applied; (In most implementations) cannot read/write individual bits // data must be read in pages and written/erased in blocks; Can use single-level cells (that store one bit) or multi-level cells (that store two bits); **A.** use of "pages" when "blocks" is meant and vice-versa. **MAX 4**	4

January 2009 Comp 2

8	(a)	**Typical Capacity**	**Storage Medium**	**5**
		10 Gigabytes – 2 Terabytes	Magnetic Hard disk //magnetic tape cartridge;	
		10 Gigabytes – 800 Gigabytes	Magnetic hard disk // magnetic tape cartridge;	
		128 Megabytes – 8 Gigabytes	Flash memory card;	
		2.8 Gigabytes – 4.7 Gigabytes	DVD-R;	
		600 Megabytes – 700 Megabytes	CD-ROM;	
	(b)	(i)	CD-ROM // DVD-R;	**1**
		(ii)	magnetic hard disk // magnetic tape cartridge **A** flash memory card **A** DVD-R;	**1**

11	1. reader sends radio frequency energy/wave; 2. to the antenna of the RFID tag in the book; 3. The RFID tag is energised by the reader/this energy; 4. the transponder (in the tag) sends the data signal; 5. the reader near the exit receives the data signal;	**MAX 2**

January 2010 Comp 2

9	(a)		**For Photodiode System:** Light/laser/LED/Infra-red light shone at bar code; **NE** beam (Moving) mirror/prism moves light beam across bar code//user moves reader across bar code; **NE** beam Light reflected back; Black/white bands reflect different amounts of light // black reflects less light // white reflects more light; Light sensor/photo sensor/photo diode/CCD measures amount of reflected light; Light reflected converted into an electrical signal; **A** convert reflection to (binary) numbers/characters (Electrical form of) reflection analysed to determine value encoded in bar code; Data transmitted as binary codes to till/computer; These values are often sent as ASCII codes; **For Camera/CCD System:** Camera/CCD measures (ambient) light reflected from bar code; Camera/CCD converts light into an electrical signal; Light reflected back; Black areas reflect less light than white; Raw image data transmitted to computer; Image analysis software analyses image to determine value encoded in bar code; **MAX 4**	4

9	(b)		Validate data entry//check bar code is valid/reasonable; Verify if bar code has been "input" accurately/correctly //check bar code not damaged/altered; **R** validate the item **MAX 1**	1

9	(c)		Keyboard/Keypad/Touch screen/Concept Keyboard/Electronic Scales **NE** scales	1

January 2011 Comp 2

5		LASER Page printer; Print drum coated in (negative static) charge; Printer generates bit map of page; Laser beams shone/directed at/"draws" on print drum; Via rotating (octagonal) mirror; Laser is modulated (turned on & off); Laser removes/neutralises/reverses electric charge on drum; where image should be dark/black; Toner is given (negative) charge; Charged drum picks up toner; Toner transferred from drum to paper; ("from drum" may be implicit in order of answer) Toner is fused/bonded/melted/stuck to paper by (heated rollers/pressure); (must be clear that toner is already on paper when it is fused, not still on drum) **I** incorrect charges e.g. positive when should be negative INK JET Heater behind ink reservoir is warmed; Vaporises droplet of ink. Expands and forces small ink blob out onto paper; Electricity applied to piezoelectric crystal; Deforms crystal shape; Fires/squirts/shoots spots of ink; **NE** places Some colours produced from mix of ink spots fired together; Heater turns off – ink cools sucks remainder of droplet back in. Repeated for all colours and each nozzle; Electric current switched off piezoelectric crystal returns to original shape; Print head moves across each line of paper/ repeated for each part of each character // Prints line by line; Ink dries before paper emerges from printer; **A** laser / ink jet printer uses (black), cyan, magenta, yellow (Note – only accept this point once)	8

January 2012 Comp 2

4	a		**Purpose**	**Media**		Mark on first occurrence of each medium.
			To distribute commercial software	CD-ROM // CD-R // DVD-R;		
			To store a 20GB high definition movie file	Blu-ray disc;		
			To use for a 3GB archive of a school server	DVD-R // DVD-RW // Blu-ray disc;		
			To create a copy of a music album	CD-R // CD-RW;		
			NOTE : Mark first occurrence of each medium		**4**	

4	b		WRITE : To write data a high powered/ high frequency laser makes sections less reflective / burns a pit; **R** – laser writes grooves/tracks; READ : A low powered laser is used to read data back from the disk; MECHANISM : The difference between reflective and non-reflective parts / pits and lands indicates the 1s and 0s; The data is stored as a continuous spiral track; One mark each for write, read and mechanism. NOTE: a laser is used to read and write data (1 mark only)	**MAX 3**

4	**c**		No hardware exists to read CD-R disks; The CD-R medium has become corrupted // CD-R is scratched/damaged/degraded; Support for file format no longer available // no software capable of reading format data stored in CD-R;	**MAX 2**

January 2013 Comp 2

5	**a**		Magnetic (medium); Binary digits/bits/0s and 1s/data represented by magnetising spots on disk // changing magnetic properties of disk; Disk made up of platter(s); Disk divided into tracks and sectors; **A.** either tracks or sectors alone Tracks are concentric circles // organised into cylinders; Drive head can move in/out // moves to track/cylinder // moves radially; Disk continuously spinning (while in operation); Disk spins at high speed // feasible example of speed; Data read/written as correct sector passes under read/write head; **A.** drive head Data transferred in sectors/blocks; Medium and drive/device in sealed enclosure; Hard disk drive is a random access device; **A.** Head parked / not over disk when not in use // head must not touch surface when in use; **A.** Use of cache/buffer to speed up data transfer; **MAX 3** if candidate talks about lasers / making holes / pins / engraving	**MAX 4**

5	b			MAX 2
			512 MB x 2 = 1024 MB = 1GB 1GB x 1024 = 1 TB 2 x 1024 = 2048 Award mark for a clear movement between MB – GB - TB making use of 1024 ; Final answer: 2048; **Acceptable alternative** (as many hard drive manufacturers do not use the 1024 principle) : 1 TB = 1000 GB = 1000000 MB; 1000 000/512 = 1953.125; (mark to be awarded for understanding the calculation needed) Final answer : 1953.125; **A.** Accept a final answer that has involved some approximation as a no calculator paper. (2000;) **Alternative** $2^{40} / 2^{29} ; = 2^{11} ;$	

5	c			MAX 1
			More platters (which are packed closer); Greater density of data on each platter; More tracks on a platter // more cylinders; Change to perpendicular magnetic domains; Ability to write smaller magnetic domains/parts // smaller read/write heads; Use of different alloy materials for the platters;	

5	**d**		Faster access speed // faster booting of operating system // faster data transfer/read/write speeds; Silent operation; Are lighter; Less heat generated; Less power required // longer battery life; Less susceptible to damage from physical shocks // more robust (due to no moving parts); **NE** quicker (without explanation) **NE** better performance (without explanation)	**MAX 2**	Accept – quicker as no need to wait for read/write head to move//sector to be underneath read/write head;

June 2010 Comp 2

4	**(a)**	**(i)**	A biological/physical/behavioural (A by example) property of a person that can be used to identify them / unique; **R** examples alone	1

4	**(a)**	**(ii)**	Fingerprint; Retina / Iris pattern / scan; **R** Eye scan Facial structure / scan; **R** Photo of face DNA fingerprint / profile; **R** DNA Voice pattern /print; Ear print; **MAX 1**	1

4	**(b)**		RFID reader/scanner (at passport control) transmits/sends signal; Signal which activates/energises/induces current RFID transponder/tag; RFID transponder/tag transmits/sends data by radio(wave); Electrical/physical contact between tag and reader not required//tag must be near to reader; Passport may need to be unlocked using Machine Readable	
			Zone(MRZ)/key; **MAX 2**	2

5	A		Flash Memory (Card); **R** memory card	1
	B		Magnetic Tape;	1
	C		CD-ROM; CD-RW; **A** Flash Memory Card if not given in first question part	1
	For all parts reject media not listed in question			

June 2011 Comp 2

8	a		40 gigabytes-2 terabytes magnetic hard disk; 4.7- 8.5 gigabytes DVD+R; 512 megabytes – 128 gigabytes flash memory card; 600 – 800 megabytes CD -R; **A** incorrectly copied device names which clearly have the same meaning e.g. "flash memory" for flash "memory card". Only mark first occurrence of each medium.	**4**

8	b		Internet connection may be too slow for (a large) download // takes a long time to download; Download can be interrupted which may cause loss of download; Worried about security of online shopping ; - Note: NOT Viruses Have physical/permanent copy to reinstall from in case of failure; **A** idea that there is a "backup" if computer failure for a BOD mark; Computer not on Internet // to install offline;	**MAX 2**

8	c		Recorded pit size is much smaller; Spiral spacing on DVD is closer/smaller; **A** "groove", "track" Different wavelength of lasers; DVD multi-layered / double sided; **A** Length of track on DVD is longer; **R** More tracks;	**MAX 1**

June 2012 Comp 2

6	a	i	Touch(-sensitive) screen;	1
6	a	ii	Smartcard reader // RFID reader // Radio Frequency Identification reader; Touch (sensitive) screen; *(if not awarded for part i)*	MAX 1
6	a	iii	RFID reader // Radio Frequency Identification reader; *(if not awarded for part ii)*	1

June 2013 Comp 2

3			**General:** The reason mark is dependent on a correct answer for device. Each reason mark must be different.		
			USB flash (drive); **A.** flash drive; **NE** USB // flash // USB drive; Small portable device (that is easily written to and read from); **NE** just 'easily transported' Files would be quite small so will easily fit onto it; No additional hardware device/drive needed to use ; Device is robust; **MAX 1 mark for reason**	**2**	

			Magnetic tape (drive); Can hold large quantities of data; Not needed for fast access to individual files; (Media is portable so) archive tape can be stored away from server; Fast data transfer; **MAX 1 mark for reason**	**2**
			DVD-R (drive); Appropriate medium for storing a typical sized executable; Can only be written to once // cannot be accidentally deleted; Media is portable (so suitable for distribution); **MAX 1 mark for reason**	**2**

4	(f)	(i)	(Lens focuses) light/photons onto image sensor; **R.** if uses 'reflection' Image sensor is a CMOS/CCD/photoelectric device; CCD used ADC to convert measurement of light intensity into binary; CMOS uses transistors to generate binary value; Image sensor converts light into discrete/electrical signals/binary; Image is captured when the shutter is pressed; Large pixels collect more electrons than small pixels and so produce better quality images; Firmware performs data processing to "tidy up" image; (Colour) filter used to generate data separately for Red, Green, Blue colour components; Aperture / shutter speed can be adjusted to cope with varying lighting conditions; Image is recorded as group/array of pixels // Image sensor consists of array of pixel (sensors)//etched into the image sensor's silicon are pixels; Image data transferred to robot; Image data usually stored on solid-state disk;	**MAX 3**

4	(f)	(ii)	Robot has a low powered microprocessor; Too much image data for the robot to process quickly // smaller resolution can be processed quicker; A high resolution image has too much image data for the robot to store // low resolution uses less storage space; Do not need high resolution to determine colour of balls; **NE** allows more images to be stored	**MAX 1**	

June 2016 AS Paper 2

08	1	**Marks are for AO2 (analyse)**	6

Level	Description	Mark Range
3	A detailed summary of the suitability / non-suitability has been given, indicating a comprehensive understanding of all three devices/technologies. The answer is well structured and a line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. A well-reasoned conclusion has been included featuring at least two reasons for RFID being most suitable for 5 marks and three reasons for RFID being most suitable for 6 marks.	5-6
2	Appropriate reasons, linked to the scenario in the question, have been given for the suitability / non-suitability of all three devices/technologies – though there may not be a reasoned conclusion and the reason(s) for RFID readers being suitable may be brief. The answer is satisfactorily structured.	3-4
1	A small number of reasons for the suitability / non-suitability of one or more of the devices have been given indicating some understanding of the input devices. However, there is no comparison and the understanding shown is not well-linked to the scenario described in the question.	1-2
No creditworthy material		0

		Indicative subject content Digital camera • Advantage: no tag/code that can be lost / damaged • Disadvantage: difficulties with taking a clear picture eg caused by blocked line of sight due to other competitors • Disadvantage: high data storage requirements for the number of photos that will be needed in a large event • Disadvantage: face recognition may not work eg due to costumed runners • Disadvantage: face recognition software not always reliable • Disadvantage: with a lot of competitors a lot of operators/cameras might be needed Barcode reader • Advantage: barcodes are very cheap • Advantage: often smaller and lighter than an RFID tag so less of a burden to competitors • Disadvantage: barcode could be obscured (e.g. by clothing) • Disadvantage: difficult to scan a code that is being moved around and is not on a flat surface • Disadvantage: some codes might be missed if a large number of competitors pass a checkpoint at roughly the same time • Disadvantage: with a lot of competitors a lot of operators/barcode readers might be needed	

		• Disadvantage: scanner needs to be quite close to code / runners may need to stop to have their barcode scanned • Disadvantage: barcode more likely to be damaged than RFID tag – when it is damaged it is unreadable RFID reader • Advantage: RFID can be read faster than the other devices and competitors may be going past the checkpoint quickly • Advantage: tags potentially reusable – saving money in future years of the event • Advantage: no line-of-sight issues • Advantage: no need for runner to stop at checkpoint • Disadvantage: potential for RFID dead spots **Note:** advantage/disadvantage for device must be an advantage/disadvantage compared to (at least) one of the other devices listed in the question for mark to be awarded.	

08	2	**Marks are for AO1 (understanding)** Because hard disk drives are cheaper (per unit of storage) than solid state drives // because SSDs are more expensive (per unit of storage) than hard disks; Because hard disk drives have a higher capacity than solid state drives // because SSDs have a lower capacity than hard disk drives;	2

08	3	**Marks are for AO1 (knowledge)** NAND (flash) memory; **A.** NOR (flash) memory **A.** Floating gate transistor **A.** flash memory **NE** memory **NE** logic gates Controller; (SATA) interface; **Max 2**	2

June 2017 AS Paper 2

10		**2 marks for AO1 (knowledge) and 4 marks for AO1 (understanding)** **Level of response question** **Level / Description / Mark Range** 3 — At least five points have been made showing knowledge of five steps in the process. The description shows a thorough level of understanding and all of the steps have been correctly sequenced. — 5-6 2 — At least three points have been made showing knowledge of three steps in the process. Good, mostly correct understanding of the process is demonstrated between 3 or more steps. — 3-4 1 — At least one point has been made showing knowledge of one step in the process. Some understanding may be shown if two steps are covered and correctly sequenced. — 1-2 **Points may include:** Print drum coated in (positive static) charge Printer generates bitmap of page from the data Laser beams shone / directed at / draws on print drum Via rotating (octagonal) mirror Laser is modulated (turned on & off) Laser removes / neutralises / reverses electric charge on drum where image should be dark / black Toner is given (positive) charge Charged drum picks up toner For drum/laser mechanisms, one for each colour (cyan etc) Toner transferred (from drum) to paper / paper rolled over drum (to transfer toner) Toner is fused / bonded / melted / stuck to paper (by heated rollers / pressure) (must be clear that toner is already on paper when it is fused, not still on drum) **A.** Reversal or lack of polarity of static charge.	6

June 2009 Comp 2

(b)

Peripheral	Input	Output	Input/Output (I/O)
Mouse	✓		
Laser Printer		✓	

1 mark for each correctly placed tick
R Answers with more than one tick on a row. **2**

12	(a)	Secondary store is non-volatile / stores a permanent copy / keeps contents when computer turned off whereas primary store is volatile / temporary / loses contents when computer turned off; Secondary store is not directly accessible to the processor / outside main memory whereas primary store is directly accessible to processor; Capacity of primary store is limited by width of address bus whereas no limit on capacity of secondary store; Data in primary store can be accessed more quickly than data in secondary store; **A** Answers where converse is implied rather than stated. **R** Secondary store is long-term whereas primary store is short-term. **R** Secondary store has a higher capacity than primary store.	**2**

	(b)	Magnetic (medium); Binary digits/bits/0s and 1s/data represented by magnetising spots on disk // changing magnetic properties of disk; Disk divided into tracks and sectors; **A** either tracks or sectors alone Drive head can move in/out // moves to track // moves radially Disk continually spinning; Disk spins at high speed // feasible example of speed; Data read/written as correct sector passes under read/write head; **A** drive head Data transferred in sectors/blocks; May be multiple platters; **A** surfaces One head per platter; Use of cache/buffer to speed up data transfer; Medium and drive/device integrated // medium in sealed enclosure; Head parked / not over disk when not in use; **MUST USE ACCURATE TERMINOLOGY AS THIS IS THE QUALITY OF LANGUAGE QUESTION**	

07			**Marks are for AO2 (apply)** **Mark Scheme** See table below	9

Level	Description	Mark Range
3	A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers both the comparison of car control and painting (see Guidance Table 1) and the use of data for car control (see Guidance Table 2). At least two points from each column of Table 1 have been made and substantiated and at least three sources of input, its processing, the derived information and why it is needed must have been addressed successfully.	7-9
2	There is some evidence that a line of reasoning has been followed. The response is relevant and most but not all points made are substantiated. The response covers both the comparison of car control and painting (see Guidance Table 1) and the use of data for car control (see Guidance Table 2) but one of these two may be covered at a fairly superficial level. EITHER: At least two points from each column of Table 1 have been made and substantiated and at least one source of input, its processing, the derived information and why it is needed must have been addressed successfully OR: At least one point from each column of Table 1 has been made and substantiated and at least two sources of input, its processing, the derived information and why it is needed must have been addressed successfully	4-6
1	There is little or no evidence that a line of reasoning has been followed. Some relevant points have been made but these may only cover one of the comparison of car control and painting (see Guidance Table 1) or the use of data for car control (see Guidance Table 2). If both have been covered, the coverage is superficial and the points made are not successfully substantiated.	1-3

Guidance

Guidance Table 1: Automated car control vs programmed control of a robot for spraying car bodies	
Robot for spraying car bodies	**Automated car control**
Exactly same operation performed over and over again by programmed robot sprayer	The environment in which the car operates is not predictable//is more complex//has greater uncertainty
Position of car bodies predetermined//car bodies in known precise positions all the time// Robot sprayer does not need to deviate from pre-programmed position at any time // a strictly controlled environment	Car system needs to know at all times exactly where it is Car system needs to recognise what it sees Car system will need a range of sensors
Actions to be performed known in advance for programmed robot sprayer	Car system has to analyse/react to an input very quickly (and then adjust one or more of the three given outputs to alter car motion)
Programmed robot sprayer requires only limited sensing of environment if any // fewer inputs to monitor	Car system has to continuously monitor many external variables
Robot sprayer does limited processing Robot sprayer has a relatively simple program which is numerically controlled	Car system has to perform very complex processing Car system will need very powerful processors

Guidance Table 2: Processing, why, sources of input data, derived information
Source of data: Radar: **Processing:** (long range) radar returns/signals processed to obtain location information of every object over a 360 degree view Plotted on a two dimensional map (for further processing). Changes in position processed Trajectories of moving objects calculated. (long range) radar returns/signals

			processed to obtain speed of moving objects Speed of the car subtracted from the speed of object. **Derived information:** Precise fix on the location of every object Distance from objects Speed information from changes in position and time Speed information from (speed) radar Direction information from changes in position Trajectories of moving objects **Why?** To keep car at safe distance from other objects//to steer car safely To negotiate roundabouts/junctions **Processing:** Radar return/signal processed to obtain speed information of objects. Speed of the car subtracted from the speed of object. **Derived information:** A zero result indicates a stationary object, a non-zero result indicates a moving object. **Why?** The car must be able to distinguish moving objects from stationary objects, e.g. pedestrian from fence post **Processing:** (short-range) radar returns/signals Separation distance between car and object Closing speed on object **Why?** To avoid collision by applying brakes automatically To maintain safe separation distance from objects at sides of car **Source of data: Stereoscopic Camera (at front of car)**: **Processing:** Separate images processed to construct view of surrounding area in 3D Machine intelligence processing used to extract important features **Derived information:** Depth information Road edge Road centre Lane edges **Why?** To predict car's trajectory Keep car within its lane Keep car on safe overtaking course	

			Source of data: High resolution video camera (at front of car): **Processing:** Video frames processed and matched by comparison with a database of road signs **Derived information:** Particular road sign **Why?** Needed to observe highway code Needed to be aware of junctions, etc. **Source of data: Global Positioning Satellite receiver:** **Processing:** Satellite signals processed to obtain location and time information Comparison made with a stored representation of road system **Derived information:** Position of car relative to junctions, etc Speed of car **Why?** Needed to observe highway code Needed to be aware of junctions, etc	

08	**1**		**Marks are for AO1 (understanding)** Solid-state memory chips are more robust; No reliance on mechanical parts that could fail; No corruption of data due to magnetic fields; Faster write speed so more data could be recorded; **Max 2**	MAX 2

04	1	**All marks AO2 (apply)**	12

Level	Description	Mark Range
4	A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all four areas indicated in the guidance below and in at least three of these areas there is sufficient detail to show that the student has a good level of understanding of the technologies required. A good level of understanding would be indicated by three substantiated points being made per area. To reach the top of this mark range, a good level of understanding must be shown of all four areas.	10-12
3	A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response but the response may only cover three of the areas indicated in the guidance below, with two or three substantiated points being made per area.	7-9
2	A limited attempt has been made to follow a line of reasoning by covering at least two of the topic areas in the guidance below. Overall, at least four valid points must have been made which can relate to any of the topic areas in the guidance.	4-6
1	A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the four areas from the guidance or may be made in a superficial way with little substantiation.	1-3

Guidance – Indicative Response

		1. Fridge capturing data from food RFID well suited as completely automatic short-range wireless transmission so no user involvement • tag does not contain a power source but is energised by reader in fridge • this causes wireless transmission of data stored in memory on tag to reader Alternatively, scan barcode/QR code as food put into fridge Barcode less suitable than RFID as only identifies product not use by date and must be manually scanned Problem of how to deal with untagged produce – possible use of voice recognition or touch screen interface Can identify products and potentially track use by dates, but how to work out how much of the product is left – refrigerators redesigned with load cells to weigh items automatically?	

2. Networking technologies

IPv4 does not have a big enough address space for the number of devices, hence introduction of Ipv6

Higher bandwidth Internet connections required for so many devices

- copper-based transmission systems replaced with fibre optic

Need for a standard (application layer) protocol for devices

Security issues with many devices connected to Internet that could be hacked

Would data be communicated to retailers directly from each device or through a server in the home?

Need to consider how to deal with interference between wireless devices, collisions etc with many more devices communicating

3. The data gathered and storage

Automatic collection of data from devices will produce vast amounts of data

This volume of data would be classified as big data

May also be classified as big data due to the velocity of data collection with so many devices

Storage could be cloud based for flexibility or close to processing cores for speed

Velocity at which data generated would make solid state storage appropriate as has fast access speeds but volume of data and lower cost per megabyte of hard disk storage may mean hard disks more likely to be used

Need to consider how long to keep data for in context of

- Storage capacity available
- Complying with relevant laws about privacy

4. Processing

		Volume of data means parallel processing or distributed processing architectures required Volume of data collected makes it unsuitable for processing by traditional relational databases Functional programming is one approach that could be used Functional programming appropriate as works well on parallel processing systems as programs do not specify order of execution Would software that managed contents of the fridge be run as embedded system in fridge or in the cloud / by the retailer? Retailers may develop a standard API to interface with devices	