IoT Enabled Smart Inventory
Project Proposal
Capstone Group 110

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BACKGROUND

TechPOS is a tech startup company based in Vancouver focusing on bridging the gap between emerging technologies and retail businesses. By using Internet of Things (IoT) and cloud technologies, TechPOS aims to deliver an intuitive yet comprehensive system that allows small to medium business owners to stay competitive with online stores and big box retailers. TechPOS values flexibility and simplicity in their products so that basic tasks can be automated, saving time and money for business owners and their personnel.

OUTCOME

Point-of-sale (POS) and inventory management systems provide the foundations for businesses. While big businesses have the capacity to use large scale automation technology, such as Amazon's warehouse robots, small to medium businesses need a smaller and cost-effective way to manage common day-to-day tasks.

One of the common areas of loss is in inventory management, where misplacing goods or incorrectly scanning the wrong items may lead to a loss in profits due to human error. To mitigate this, TechPOS seeks to develop an IoT-based solution using a container that tracks the weight of its contents and publishes this data to the cloud, where users can track inventory in real time.

A successful completion of this project would provide the company a minimum viable product (MVP) that is scalable, so that it can be further developed into market-ready and production-level designs. It is anticipated that the product will allow the company to add to their existing product line-up, creating more value for their current customers and help them expand into more industries with a more comprehensive POS system.

DELIVERABLES

The general functionality of the product is a compartment which communicates its holding inventory in real time to azure cloud. Each container provides end user accessible settings; editable settings regarding product quantity, weight and type.

The prototype must be developed with low mass production cost in mind. One of the primary constraints for this project is production cost. However, there is flexibility with prototype cost. The total prototyping cost is expected to be more than the production per unit cost.

The final product is divided into smaller incrementally achievable parts. The technical constraints associated with deliverables of each modules can be seen in Table 1

Table 1 Technical Constraints breakdown

Module	Technical Constraints
Weight Sensor	Sensor must have 1 mg of sensitivity but able to handle up to 700g -1000g
Data Transfer	Data transfer between end and edge devices must be wireless. Data transfer between edge devices to cloud must be wireless.
End Device(s)	Must communicate to edge device(s) via a low bandwidth communication protocol
Edge Device (s)	Must communicate to end device(s) via a low bandwidth protocol. Must communicate to cloud via a high bandwidth protocol. Must be Azure API compatible
User Interface	Must be simple to non-technical end users Must be developed with Azure

The system is modularized to three major parts. See Figure 1 & 2 for visualization of system. The break down is s follows

1) End device (with weight sensor) sends data to Edge device (middle layer) via IoT protocol.
2) Edge device sends data to Azure IoT Cloud via internet protocol (Wifi, Ethernet)
3) IoT Hub, User can access data from End devices via Azure Interface

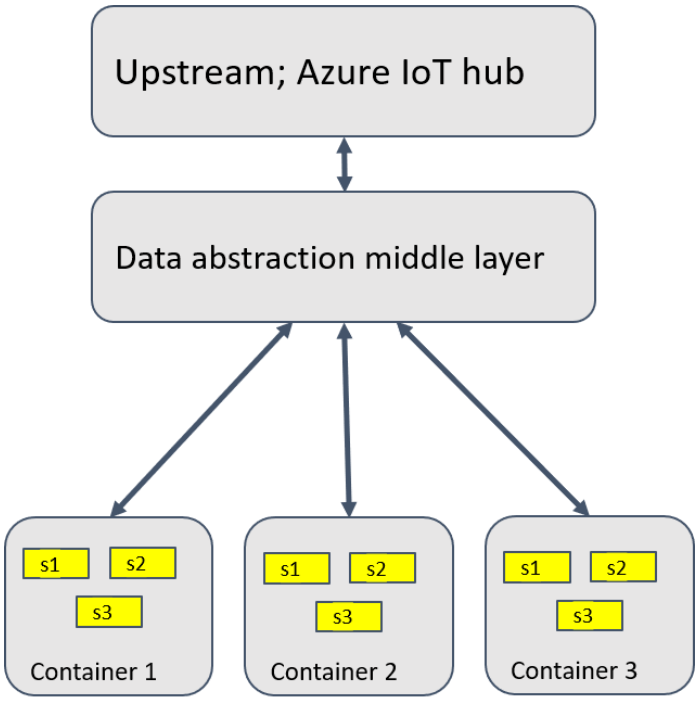

Figure 1 System Overview

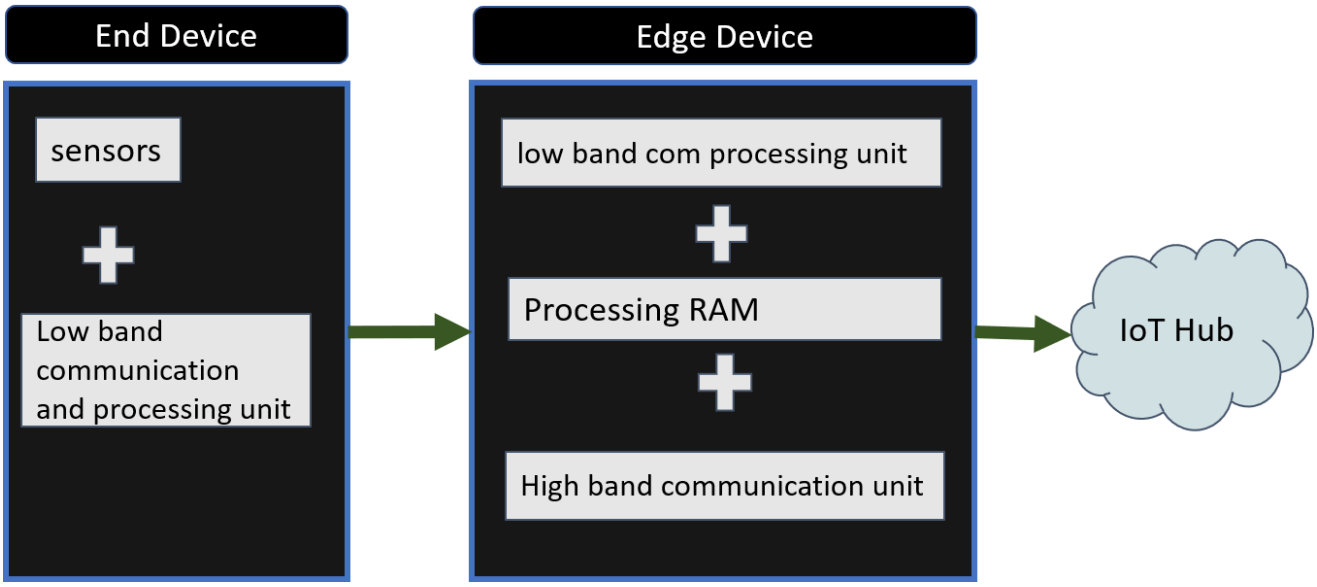

Figure 2 System Breakdown

BUDGET

The total cost of major parts, before shipping, discounts and taxes, is anticipated to be 335.94 CAD. Allowing for additional

- 100 CAD for miscellaneous items such as jumpers, ADC-SPI chips etc.
- 100 CAD for Azure cloud

This brings the total prototype anticipated costs to 535.94 CAD, which remains below the $650 budget.

Table 2 Preliminary BOM

Type	Product name	Product Description	Distinguishing feature	Quantity	unit Price	Total
dev board - edge	Raspberry Pi 3 B+	Quad Core 1.4GHz 64-bit CPU and 1GB RAM 4 USB Ports	Wireless LAN (WiFi) on board	1	56.99	56.99
dev board - end	Arduino Uno	R3 ATMEGA328P EVAL	End libraries available	1	31.48	31.48
RF com chip - Zigbee	XBP24CZ7SIT-004	802.15.4 Zigbee® Transceiver Module 2.4GHz	Arduino and pi compatible	2	49.62	99.24
xbee Breakout board pi	WRL-11812	XBEE EXPLORER USB	convenient compatibility	1	37.13	37.13
xbee breakout board arduino	DFR0015	XBee Expansion Board	convenient compatibility	1	15.9	15.9
load/ weight sensor	0.78 Kg Micro Load Cell	micro load cell	0.1g accuracy	3	7.99	23.97
load cell wheatstone bridge/breakout	HX711 Load Cell Amplifier	Two-wire Clock and Data Four-wire wheatstone bridge	compatible with micro load sensor	3	13.31	39.93
power	Raspberry Pi 3 Power Supply 5V3A	Wall plug power cable	-	1	15.99	15.99
cable	Ethernet Cable	-	-	1	5.99	5.99
memory - need for operating system	SanDisk 16GB Ultra microSDXC	-	-	1	9.32	9.32
					BOM Total	**335.94**

PROJECT MANAGEMENT

Project Assumptions

The following includes individual team member expectations

1) Access to facilities for brainstorming, planning, discussing, prototyping and developing the product will be readily available.
2) Communication and networking infrastructure like Slack and Google Drive will be readily available and efficiently used.
3) Financial resources- a minimum of $650- for product development will be easily available.
4) Project scope will not deviate significantly and ample time will be provided to integrate changes to the scope.
5) Personnel and economic costs will remain stable throughout the project.
6) Technological services and devices used will be easily integrate-able.
7) Group will be cohesive and members will be accommodating, compromising and professional. Conflict resolution guidelines will be followed whenever issues arise.
8) Inbound dependencies will be received in time insignificant to that of the entire project development. Enough time is also available for development of the outbound dependencies.
9) All members either possess or will gain relevant skills or achieve the project objectives

Project Risks

1) Risk of changes to project scope, especially late in the product development stage.
2) Budgetary risk of cost overruns due to uncertainty in cost estimates.
3) Integration risk of technologies- hardware and software- working in tandem.
4) Resource risk of securing facilities and parts.
5) Disputes, especially within the group and between stakeholders.
6) Schedule risk based on uncertainty in determining project timeline and other delays.
7) Skills risk based on inexperience of group members with respect to implementation of specific tasks.
8) Quality risk, based on the final outbound dependencies as to if they fit the criteria and reliably perform.
9) Project complexity based on the size and intricacy of the project relative to the capabilities of the group.
10) Design risk, where the design will fail to meet the requirements of the client and hence rejected which must then be redesigned.

Project Dependencies

- All inbound dependencies are specified in the Anticipated BOM spreadsheet.
- Outbound dependency is smart container that weighs and displays (not necessarily on container) number of contents inside. Will include real time data handling so as to have live smart inventory system. Further specification provided in deliverables section.

Project Constraints

1) Limited budget of about $650. Possibility of additional funding by the client.
2) Availability of facilities and availability times of group members.
3) Staffing constraints based on availability of group members, instructor and client.
4) Quality and product constraints listed in relevant sections.
5) Risk tolerance of the client.
6) Deadlines for milestones and deliverables.
7) Adequate level of care, judgement and investigation so final deliverables meet requirements.

Roles and responsibilities

Communication with stakeholders is evenly divided amongst group members on a rotary basis.

The technical responsibility of each member can be seen in Table 3

Table 3 Team Member Technical area

Team member	Area of responsibility
Ammar Rehan	Project management. Low bandwidth, low power communication protocols
Adil Saldanha	Hardware and software integration
Wency Go	Software data handling - software QA
Melika Salehi	Cloud integration of edge devices

Conflict Resolution

Our approach to conflict resolution will be one of identifying needs and perceptions of relevant parties. Emphasizing on efficient communication, accommodating and compromising when reasonable. Further development and implementation of conflict management strategy is specified in the appendix.

Appendix- method for conflict resolution

The following is a draft of our 5-step method of conflict resolution which will be further refined according to our needs.

1) Build trust to surface relevant information that would otherwise not surface. Form groups of two and enter a private room. Choose the first person to speak for 5 minutes about:
    a. How am I feeling about my work, my team and my work on the team?
    b. What challenges me and what do I find hard?
        i. Other person stays quiet however can take notes.
        ii. The other participant answers the following questions in order:
            1. What is really going on?- What are the root causes that you feel are responsible for the other person feeling comfortable or uncomfortable.
            2. What does this person fear?- this is to encourage empathy
            3. How does having this fear make this person a great person?- determine the positive reason for which the person has this fear.
            4. What does the group need to know?- contents of this analysis are to be kept confidential however the most important abstract points must be carried on. The person can clarify which points they do not want to be mentioned in the group.
            5. Refrain from giving feedback to the person of the contents of your analysis.
            6. Then you switch to the other person and repeat the process. Allow 5 minutes for the first part (expression) and 10 minutes for the second part (analysis). For both people, the total process will take 30 minutes.
2) Go back into the shared room to meet with team.
3) Make an agenda of all the things the team must discuss.
4) Discuss all the points that the group needs to talk about. This is hard since it can lead to members being triggered which results in them ceasing to ask smart questions and listening attentively. The first objective is to ask for every point on the agenda, "what do you want", which serves to get everyone's positions. Then ask, "what is it about that position that is so important for you?", getting everyone's interests and needs. We are often not compatible at the level of positions but often are at the level of needs. Then we brainstorm to reach options and solutions to satisfy not the positions but the needs and interests of conflicting parties.
5) Reach conclusions (solutions/options) to all points in the agenda. Everyone must agree to these conclusions, however, it is important that one does not agree to them when they have other reservations, since then the issue will come up again. Return to previous step to reach a conclusion that everyone can agree with.