Unit 1 – Internet of Things

"A dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'Things' have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network"

The definition that Rob van Kranenburg gave in 2008 covers the main idea of what the actual Internet of Things and every device connected in its web is. It is a general idea of how it should act and the bare necessities that each device needs in order to participate in the network, leaving aside any device specifications.

This system is host to billions of 'things' that are distributed globally, yet all interconnected, not by wires, but by different networks, the main one being the Internet. Its dynamic property comes from the fact that devices cand come and go as they please, it is never a fixed size.

The self-configuring capabilities mean the ability of the network to comply with the needs of the devices, the data that has to be gathered.

Its base lies in the network itself and the actual communication protocols that transfer data from one device to another, following a standard so that any device can communicate freely.

The 'Things' of 'Internet of Things' refers to a multitude of physical or virtual objects, from physical sensors that can measure a wide range of properties (temperature, position, sound, magnetic fields, optical sensors etc.) to everyday objects - kitchen appliances, cars, thermostats, baby monitors, all connected to the internet via embedded systems and all the intermediary virtual nodes that gather the data and perform computations.

Each 'thing' has its identifier, that needs to be unique (for the given context), to be used in asset tracking, for provenance and quality control or to tie a user/company to a particular device.

They also have physical attributes and virtual personalities, the physical part meaning all the actual components, from the sensors to the circuit board to the actual device. On the other side, the virtual personality refers to everything that happens 'behind the scenes', with the data itself, the processing, the communication from one device to another in order for the whole system to work.

IoT projects need intelligent interfaces such that the end user can have a good experience while interacting with the device. The interfaces can come in different varieties, tactile (buttons, switches, sliders) or visual (screens, 8 segment displays) on the device itself or UIs in phone apps or even web apps, depending on the purpose and scale of the given project. Some can even have a combination of these, physical switches for on board-function and remote configuration.

Lastly, every component is seamlessly integrated in the network since each and every device is connected through a medium to one another and can pass data through each other.

Resources:

- Course resources
- https://euagenda.eu/upload/publications/identifiers-in-internet-of-things-iot.pdf
- https://www.oracle.com/internet-of-things/what-is-iot/
- https://www.techtarget.com/iotagenda/definition/Internet-of-Things-IoT

Tatu Bogdan
Pharmacy Vending Machine

<table>
<tr>
<td rowspan="2">PROBLEM
Needing highly skilled employees to work pharmacies.
High cost of land and construction spending for a physical location.

EXISTING ALTERNATIVES
An actual traditional pharmacy.</td>
<td>SOLUTION
A vending machine used to dispense pills where people can join the “network” by creating an account and either get non-prescription pills or insert the prescription into the app and tie it to a physical vending machine so that it can be brought at that machine for the needed rate.</td>
<td rowspan="2">UNIQUE VALUE PROPOSITION
Easy and reliable way to get medication.

HIGH LEVEL CONCEPT
A vending machine for prescription / non-prescription pills.</td>
<td>UNFAIR ADVANTAGE
The user ease of use, not having to wait around and everything being at the push of a button. With features as reminder notification, in app map to nearest location that has the necessary medication. User’s payment and medication history all in one place.</td>
<td rowspan="2">CUSTOMER SEGMENT
Anyone that could legally afford and obtain said medication.

EARLY ADOPTERS
People who want keep track of their medication and want security that it will be there when needed.</td>
</tr>
<tr>
<td>KEY METRICS
• number of customers
• types of medication sold</td>
<td>CHANNELS
• already built machines
• mobile app</td>
</tr>
<tr>
<td colspan="2">COST STRUCTURE

• production of the vending machine
• space rental
• medication itself</td>
<td colspan="3">REVENUE STREAMS

• medication pricing
• bonus pricing for shipping
• non-intrusive adds
• partnerships with well-established healthcare companies</td>
</tr>
</table>

Unit 3 – Cloud Architecture

Edge Computing

Edge computing is a distributed computing method that handles part of the processing and storage of data closer to the data sources (sensors), the “edge” of the network. It can happen on the actual IoT devices or a dedicated local edge server.

Even though it is related to cloud and fog computing, all of them serve a different purpose. Unlike cloud computing, where most of the actual application logic is done in a centralized manner, and fog computing, that helps in filtering the important information from the heaps of data gathered from the device, edge computing is tasked with preprocessing the raw data from the sensors to send it further up the chain. The main use of edge computing is to alleviate the required bandwidth to send the streams of device-generated data and processing power needed for said data that the network, respectively the data center would’ve had to provide. It also helps with latency issues that would rise from sending the data to and from the centralized server.

It is not necessary per se, since we’ve done without it the last couple of decades. It is a needed for fields where time-sensitive events are happening or the aforementioned limitations. The transition is slowly happening do the rise in computational power of smaller devices and personal devices and the motive to take advantage of that progress.

Cloud Architecture in IoT Architecture

The cloud architecture can be one of the layers of an IoT device architecture. To be exact, in a three-layer architecture (application – network - perception) It represents the application layer, where it delivers the application specific services to the user. In a five-layer architecture (business – application – middleware – transport - perception) it functions as the middleware component, used to store, process and analyze vast amounts of data passed through the transport layer by the devices, which might utilize cloud computing or big data processing resources.

It’s a centralized method to process and present data and brings a lot of advantages over traditional private business servers. Outsourcing has brought better accessibility, reduced costs for already implemented services like traffic and data analysis, load distribution and better scalability, since the workload can be passed to already connected idle devices.

Resources:

- Course slides
- https://www.netburner.com/learn/architectural-frameworks-in-the-iot-civilization/
- https://www.ibm.com/cloud/what-is-edge-computing
- https://www.onlogic.com/company/io-hub/fog-computing-vs-edge-computing/#:~:text=In%20a%20nutshell%2C%20edge%20computing,purposes%2C%20such%20as%20data%20filtering.

ACTIVITY PITCH QUESTIONNAIRE (APQ)

ESA-TIAA-PO-2017-1054 - V.1.29

The present questionnaire intends to collect in a standardised way information on various aspects of your idea / proposition regarding the IoT device, in order to understand:

i. what is the level of expertise / know-how of the proposer;

ii. what is the current level of maturity;

iii. what is the business target and business potential.

Please, keep your answers to a **maximum limit of <u>10 pages</u>**, maintaining font size and structure.

Section AP.1: Background information

AP.1.1 Idea name:	Pharmacy Vending Machine
AP.1.2 Team proposing: *(names and e-mail)*	Tatu Bogdan (bogdantatu10@gmail.com)
AP.1.3 Does your team (company / consortium) have the right skills and experience to deliver what you are proposing? *(Yes/No/Partial + comments. Please indicates which skills/expertise you possess/miss)*	No: The programming knowledge necessary to create the system is there, but it's in need of more than that, the workforce to build and sustain the system. The outsourcing needed for the manufacturing process of the actual vending machine and the necessary circuitry that has to go inside the device. Another big problem would be the actual logistics of the whole project, the need for constant resupply. A minor/major inconvenience can also be the legal side of the project, but I'm not really versed o this part enough to see how costly it would be. It would need to be a full scale business to actually implement, with enough funding to get everything started.

Section AP.2: What do you want to offer and what is the added-value?

AP.2.1 What is the final service that you want to offer?

A system of vending machines that can supply non-prescription pills to anyone passing by like a regular vending machine or prescription pills to users that are already using the network and have requested shipments to a given machine based on the prescription (the medication, the dosage, the amount that can be sold). They can communicate with the central cloud when it comes to stock and restock and show a comprehensive map of all the locations that have a given product.

AP.2.2 Who will be the customers/users of the final product / service?

(please note: users and customers can be different:
users will use the final product/ service but they do not necessarily pay for it;
customers will pay for the service, but they do not necessarily use it)

The customers and users are the people that are in need of medication, the same as the ones that would buy from a pharmacy, but want everything taken care of by the application and the network. Another customer could be pharmacies in need of broadening their reach, but not having the revenue to open shop in different locations, they could use the vending machines for their needs and also join the network.

AP.2.3 What are the customers'/users' pains (e.g. problems) and gains (e.g. benefits)? Can you quantify them?

(please note: whenever users and customers are different, pains and gains can be different as well)

The pros would have to be the ease of use, by either physically going to that location on acquiring the needed products in a few moments or apply for delivery when needed at an extra cost. The ease of changing the vending machine address to be delivered to in case of anything. The 24/7 uptime and low maintenance and upfront costs, not needing specialized personnel, would be a great selling point for other pharmacies wanting to join the network. Scalability can be another gain, since everything that's needed is just another device. Less error prone since it removes the human aspect, medication won't be given out accidentally.

One of the biggest problems that could arise would be the adoption of the machines, if not done properly. Another big issue would have to be the changes of medication, since they're not full-sized pharmacies, not everything can be stored inside, compromises have to be made, and fluctuations in user needs cand bring higher logistic costs.

Section AP.4: How do you intend to implement?

AP.4.1 What is the starting point before you start the activity you propose?

(e.g., idea, prototype, existing product, existing service, results from other activities, discussions with potential users)

The are a few existing services that resemble the idea, but all of them work like normal vending machines, without the "smart" part that tie in the user to all of this. The manufacturing technology is there, the big step is integrating the actual hardware and software into the machines and the creation of the backend and applications that users can utilize.

AP.4.2 What are the key activities you propose to execute?

(e.g. commercial aspects: market analysis, winning over potential customers, business case investigation/definition, validation of business plan assumptions, preparation of service level agreement

e.g. technical aspects: proof of technical feasibility, proof of concept, design, development, integration, testing validation with pilot customers)

The main focus for our IoT&SN course is related to the technical aspects. Please include here: the system architecture (you have to provide a picture), detailed descriptions of the involved parts:

-what board/boards you use and why;

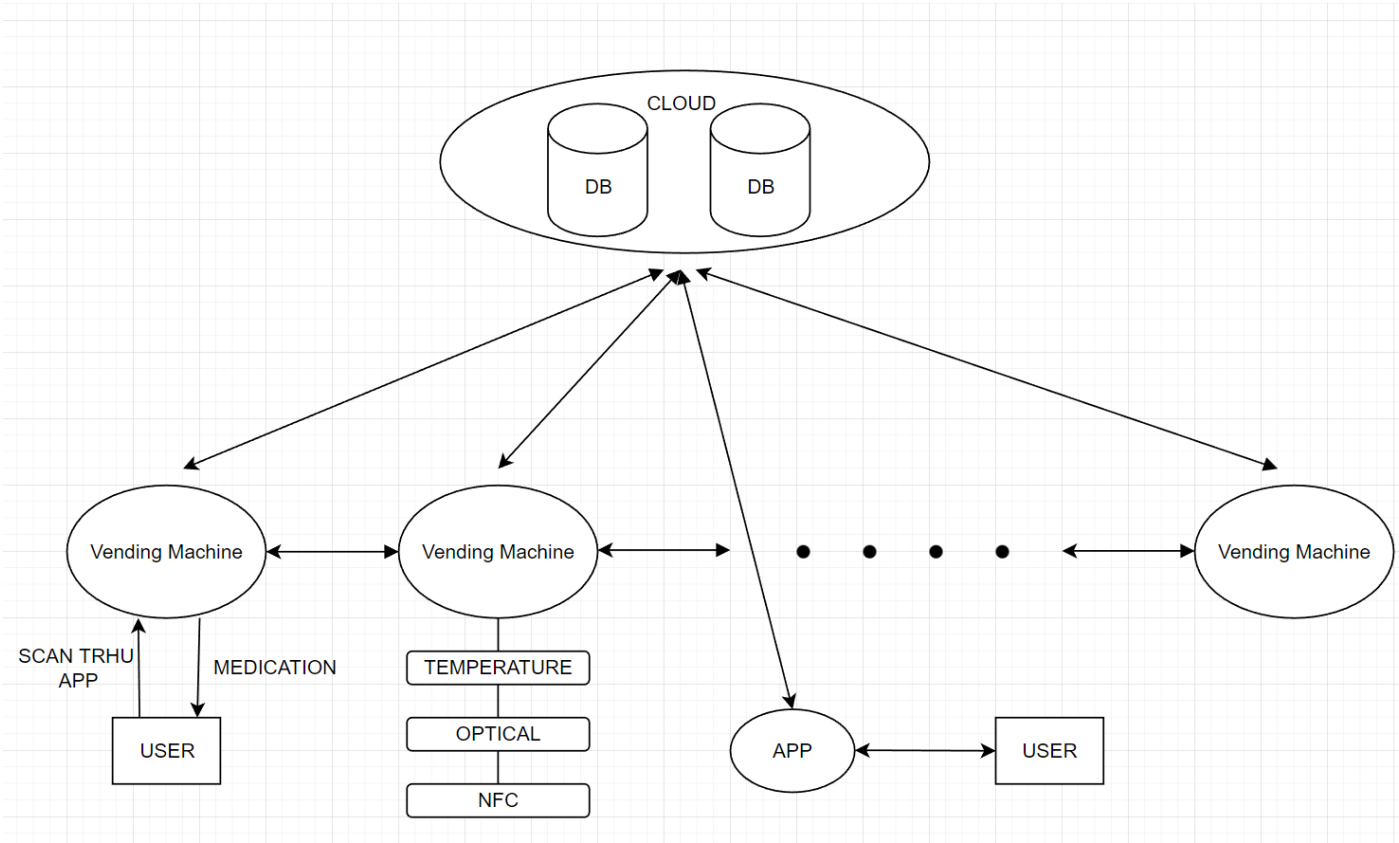
-what sensors;

-do you use Blink as mobile app?

-Do you consider using an IoT Cloud service?

You can take as an example these IoT specifications: https://cv.upt.ro/mod/url/view.php?id=52375 -- system architecture, implementation details, schemes etc.

The system architecture can be drawn in draw.io or any other tool



The boards do not have to be top of the line, since not a lot of processing needs to happen on-site, just enough to deal with the sensor data.

The scanners needed are ones to track the temperature of the units, visual sensors for scanning off apps and NFC sensors for payment.

The mobile app will only be used to send requests, process payment, show a map of the physical devices and their products and for use of the vending machines to know the user making the request.

It would implement an IoT Cloud service for the processing of data and requests of users, updates on the actual medication, to notify the user in case something comes up, missed medication or changes in supply, also gather the user data required for transactions and the supplying of machines.

The machines will also be able to communicate with one another for customers without apps in case of a missing product in one to give directions to a nearby device.

AP.4.3 What are the most important risks (technical / business / commercial) to your activity? What are your mitigation plans?

Upfront costs and uncertainty in early adoption, since the network would only become more useful as it grows. There needs to be an active advertising campaign showing the ease of use of the whole system.