

Introduction to System-on-Chip and its Applications

Group Final Project Report

Smart Laundry

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1. Introduction

Laundry is a must-be work at least once a week. It is an easy thing that laundry should be. However, it can also be a cumbersome work. No matter what, there is no denying that laundry takes time.

Thus, how to do this efficiently is important for everyone. This report will present a concept including some laundry relative IoT device, laundry cloud servers, and mobile phone application. As shown in Figure 1, smart hanger is not an ordinary hanger, but an IoT device with a humidity sensor that can be used to judge whether the clothes hanging on the hanger are dry or not. Smart basket is also an IoT device, using Ultrasonic Distance Sensor to calculate the height of the stack of clothing placed in the basket. Smart Washer/Dryer can read some clothing information through RFID and can act as a coordinator between IoT devices and Laundry Cloud.

At the back end, cloud servers can provide some services for front-end application and can use these IoT data to do some statistics, helping for optimize laundry scheduling, reservation, management, alerts for improper use, notifications, and so on. Help for customers and even administrators for home use or commercial use.

The structure of this report is organized as follows:
In Section 2, we will mention System and structure including overview of system, hardware, software, and laundry cloud. Introducing the whole design what Smart Laundry should be like, and all the hardware used for the Smart Laundry. Describing the application of Smart Laundry, what are the functions and features. The spec of Laundry Cloud and its architecture are also be presented. In the end of this Section, some application scenarios are envisaged. In Section 3, market analysis is discussed such as target audience, competitor, and so on. Finally, reference and task partition are listed.



Figure 1, the concept of Smart Laundry

1.1 Motivation and application

This is a common occurrence, especially if you share the washer/dryer with other people. Want to do laundry, carry a basket to the laundry room, look around, and find that there are no idle machines. So, you're spending time waiting for a machine to become available. You finally wait for an idle machine and put your laundry in, so you leave satisfied to do other things. After a long time, you forget to collect your clothes. If you are unlucky, your clothes will be taken out by others and thrown aside. They will be dirty and needed be washed again. You spend a lot of time just washing your clothes. Afterwards, you want to dry your clothes by hanging them outside. Unfortunately, the weather is bad, and your clothes are not dry. You spend a lot of time constantly checking to see if your clothes are dry. Eventually you can't take it anymore and you decide to take your clothes to dry in the dryer, and as a result, it happens again that there are no idle machines to use.

Your actual laundry time is always far away than your ideal laundry time, as shown in Figure 2, illustration of actual laundry time

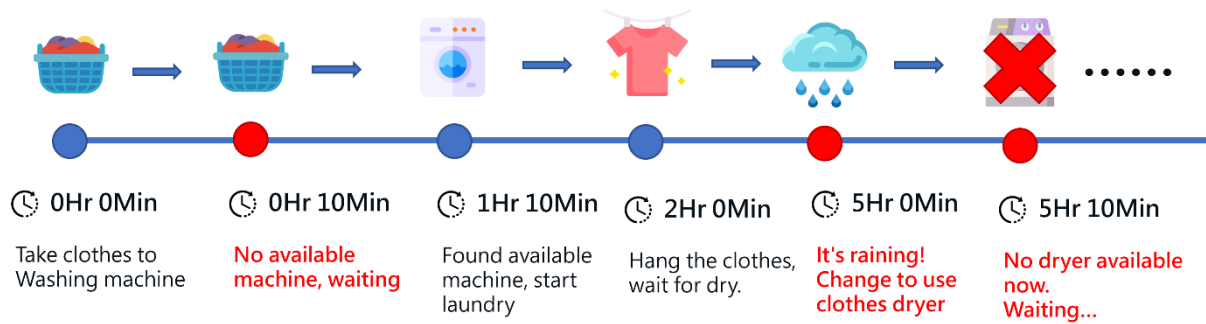


Figure 2, illustration of actual laundry time

We spent too much time to do the laundry

Wait for available watching machine → 25Min ~ 50Min

Bad weather cause the clothes hard to dry, even redo the laundry → 12Hr ~ 24Hr

Wait for available clothes dryer → 30Min ~ 2Hr

No complete notification, task done but not yet to get your clothes → 1Hr ~ 24Hr

It comes out that we waste more 8 hours per once in average time. If we do the laundry twice per week, we will take 786 hours per year. As shown in Figure 3, it looks awful right?

Average waste time: 8 Hr per once (Worst Case)

Do laundry twice per week → **64 Hr/month, 768 Hr/year**



Take the lecture with 3 academic credit in 1 semester

→ **60 Hr, you can take additional 12 lectures** in one year



Take 20 Hr you can learn one skill

→ **You can learn additional 38.4 skills** in one year

Figure 3, The time you waste in one year.

So, how to make the whole laundry time efficiently is an important work. What's more, there is still a problem. Clothes can be damaged by incorrect washing or drying methods, such as drying sweaters on high heat. However, it is not a common knowledge for everyone. A person who just wants to wash a new cloth, but it is damaged without wearing it even once. It sounds regretful.

Thus, we purpose Smart Laundry hoping to deal with the above-mentioned problem and make the whole laundry more efficiently and accuracy.

2. System and Structure

2.1 Overview of system

The overview of our system is shown in Figure 4. In our system, users can reserve a smart washer or a smart dryer and check the machine status through Laundry Cloud APP. In addition, if the washing or drying process is done, Laundry Cloud APP will notify users to collect their clothes. Furthermore, depending on the corresponding RFID tags, a smart washer can recommend user a washing process that is suitable to the clothes material. Sometimes, people may forget to do the laundry until they find out that they don't have any clothes to wear. To avoid this situation, the smart basket will notify users through the app if the dirty clothes in the basket are getting full. With a humidity sensor and a sunlight sensor, the smart hanger will predict whether the clothes are dry or not and notify users to collect the clothes.

In summary, our system can provide a laundry reservation service that can help users save time. In addition, the clothes-collecting notification allows users to schedule their time rather than checking the clothes repeatedly. Furthermore, the RFID tags make sure the washing process or drying temperature is correct and won't cause damage to the clothes.

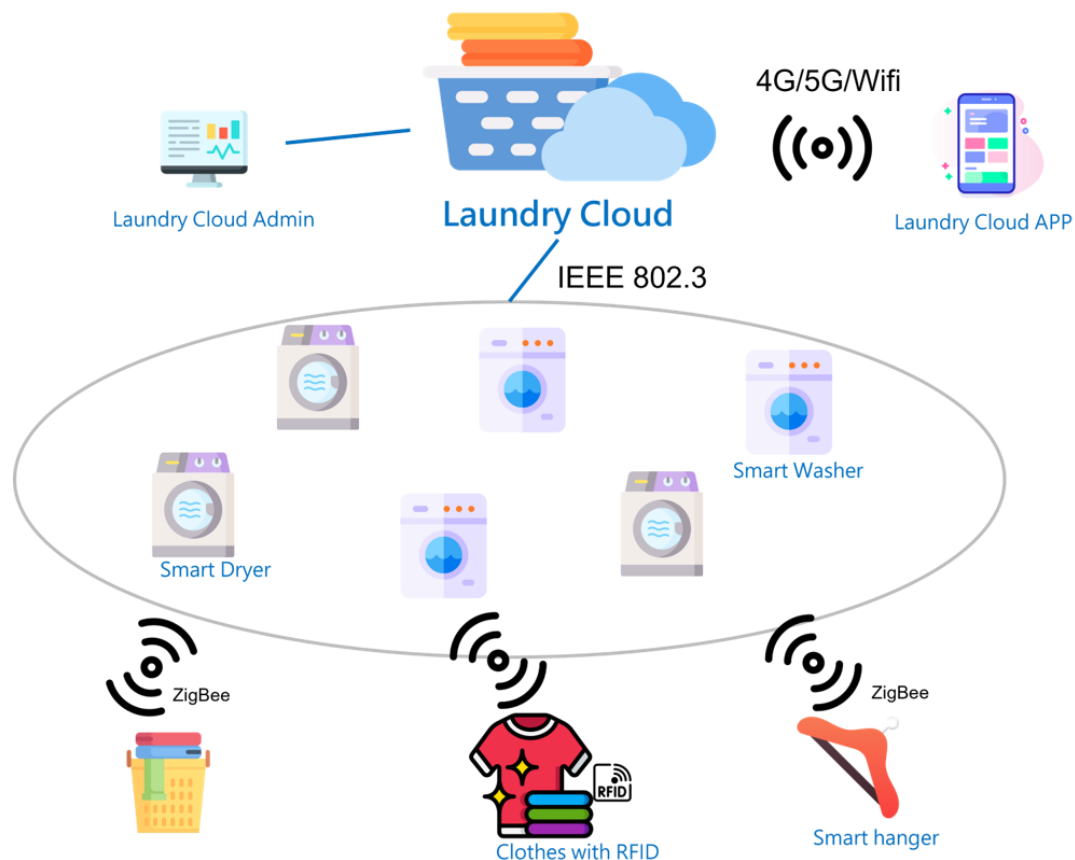


Figure 4, Overview of system.

2.2 Hardware

The main products in our smart laundry room is shown as following:

- Clothes with RFID
- Smart hanger/ Smart cloth rail
- Smart basket
- Smart washer/ Smart dryer

Clothes with RFID: Depending on the clothes' material, corresponding RFIDs are tagged on each cloth. The RFID tags help smart washers or smart dryers to identify different clothes materials. Thus smart washer can provide a suitable washing process and a smart dryer can recommend user different drying times or temperatures, according to the clothes material. To make sure RFID tags can endure the laundry processes, we use UHF RFID Laundry Tag (RW700 RF), as shown in Figure 5, which main key features have high temperature waterproof and washable, high humidity resistance, washable soak, repeated rubbing, direct ironing, sewing . And it has the characteristics of high sensitivity, strong anti-interference ability, and excellent multi-tag reading and writing performance as well. The product description is shown in Figure 6.

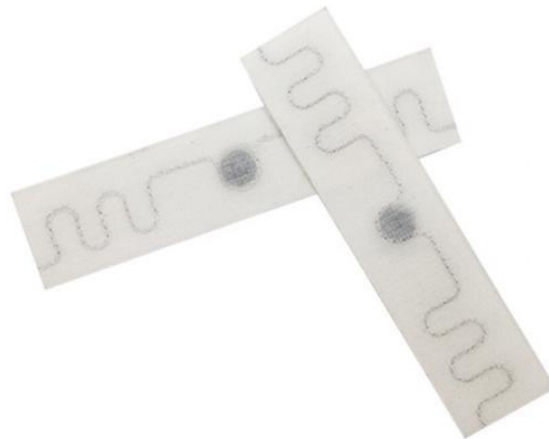


Figure 5, RW700 RF.

Specification	Fabric Textile Washable UHF RFID laundry tag
Frequency	860-960MHz
Chip	Fixed reader over 4m handheld reader over 2 UHF (H3, MONZA R6/ R6-P and other UHF transponder)m
Protocol	ISO/IEC 18000-6C & EPC global Class 1 Gen 2
Reading distance	(Distance varying upon the tested Reader)
Material	Textile
Size	86 x 16 mm & 70 x 15 x 1.5 mm & 75*11*1.5 mm or Customized size
Thickness	COB+waterproof cloth+metal fiber line
Packing material	1. Washing: 90°C(194°F), 15 minutes, 200 cycle 2. Pre-drying in Tumbler: 180°C(320°F), 30minutes 3. Ironer: 180°C(356°F), 10 seconds, 200 cycles
Operating temperature	135°C(275°F), 20 minutes Sterilization Process: 135°C(275°F), 20 minutes
Storage Temperature	-40°C~ +85 °C
Working time	200 wash cycles or 2 years from shipping date (whichever comes first)
Weight	About 0.7g/piece, 1.5kgs/bag, 6kgs / carton
Package	200pcs/bag, 5bags/inner box, 7 inner box/ carton

Figure 6, Description of UHF RFID Laundry Tag.

Smart hanger: Smart hanger is an IoT device with humidity sensor and using Zigbee to transfer humidity data to the nearest smart washer/dryer and then to the laundry cloud. Using the humidity data, it can automatically detect whether the cloth hung on the smart hanger is dry or not. If dry, then Smart Laundry APP will notice the user who can pick up their clothing.

As shown in Figure 7, hardware of smart hangerthe humidity sensor (SHTC3-TR-2.5KS) is connected to a microprocessor(pic12f675) in order to receive humidity data and into the accepted data for JDY-40, a Zigbee transmitter. The size of these three chips is up to 1.3cm*2.3cm is small, so it is capable to set them into a hanger.

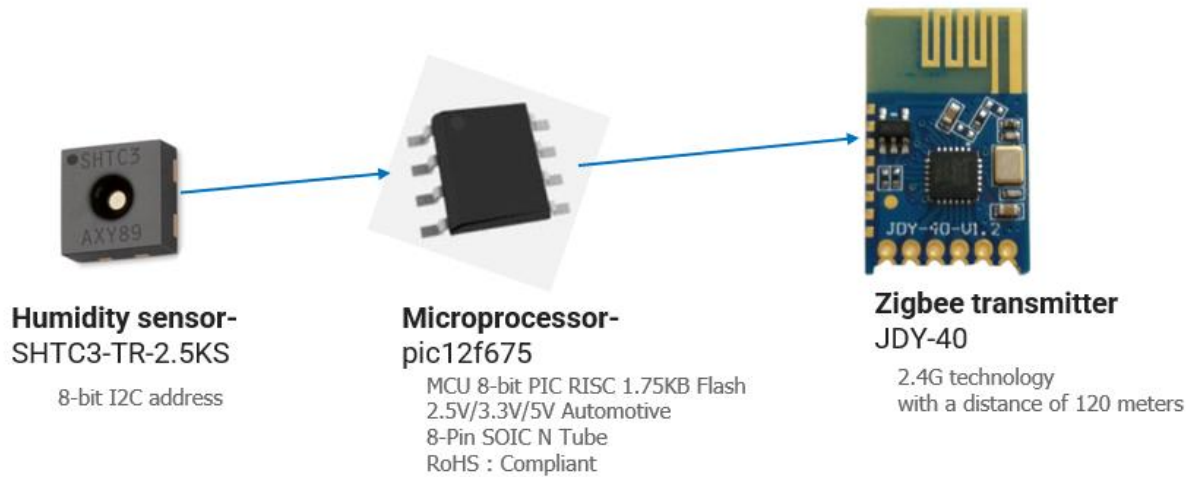
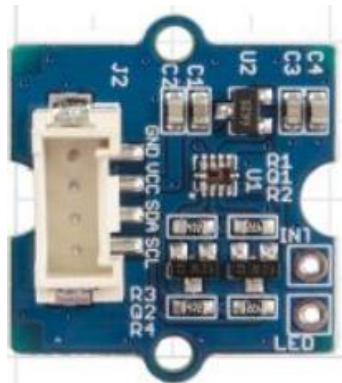


Figure 7, hardware of smart hanger

Smart cloth rail: Smart hangers which are hung on the smart cloth rail has no power demanding problem because smart cloth rail has wireless charging function. It can provide the power required by smart hangers. And smart cloth rail is also installed a sensor, Grove-Sunlight sensor, which can detect sunlight directly. These sunlight data is transmitted to the laundry cloud via the smart washer/dryer using the Zigbee protocol. With the help of local sunlight data, some recommendations or optimization services of Smart Laundry can be more accurate.

The Grove-Sunlight sensor is shown in Figure 8, which is a Digital light sensor and is programmable configuration, so using this sunlight sensor are more flexible.



Operating Voltage	3.0-5.5V
Working current	3.5mA
Wave length	280-950nm
Default I2C Address	0x60
Operating Temperature	-45-85°C

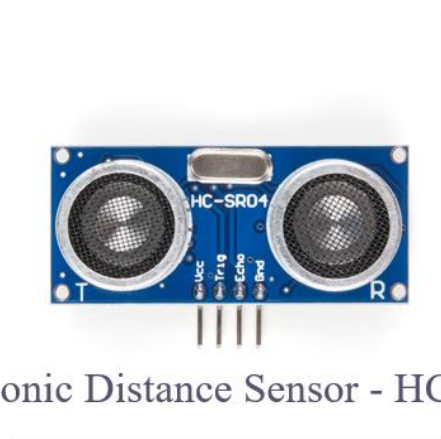
Figure 8, Grove-Sunlight sensor

Smart basket: The Ultrasonic Distance Sensor is placed in the top of smart basket and used to detect the amount of clothes. As shown in Figure 10, the Ultrasonic Distance Sensor is connected to WEMOS D1 R2 V2.1 with ESP8266EX microcontroller which helps to transform data to the laundry cloud through WIFI. Ultrasonic Distance Sensor (HC-SR04)

and its wire connecting are shown in Figure 9.



Figure 9, Smart basket data flow.



Ultrasonic Distance Sensor - HC-SR04

- 5V Supply
- Trigger Pulse Input :10uS TTL pulse
- Echo Pulse Output
- 0V Ground

Figure 10. Ultrasonic Distance Sensor (HC-SR04).

The specification of WEMOS D1 R2 V2.1 is shown as following:

- Microcontroller: ESP-8266EX
- Operating Voltage: 3.3V
- Digital I/O Pins:11
- Analog Input Pins:1(Max input: 3.2V)
- Clock Speed: 80MHz/160MHz
- Flash: 4M bytes
- Length: 68.6mm
- Width: 53.4mm
- Weight: 25g

Smart Washer/Dryer: Smart washer and Smart Dryer function similarly. They both act as coordinator between smart hanger/cloth rail and laundry cloud, so Zigbee transceiver is needed. Using 424-PMOD-RF2 to receive the IoT data from above mentioned IoT devices and transfer these data into Laundry Cloud through a microcontroller (Arduino Uno R3) and a processor (Raspberry Pi 3 Model B+).

As for how to use RFID to identify the cloth, use the RFID reader (NUCLEO-NFC03A1) to read the cloth put in the smart washer/dryer. These RFID data are transfer to the same processor (Raspberry Pi 3 Model B+) instead of Laundry Cloud, because the processor installed in the smart washer/dryer is enough to calculate which laundry method is suitable for these cloths. Only when two garments have conflicting laundry styles does the Smart Washer/Dryer's processor send an alert to Laundry Cloud, and the user's laundry app receives the alert. As shown in Figure 11, hardware of Smart Washer/Dryer, the above description is illustrated in this figure.

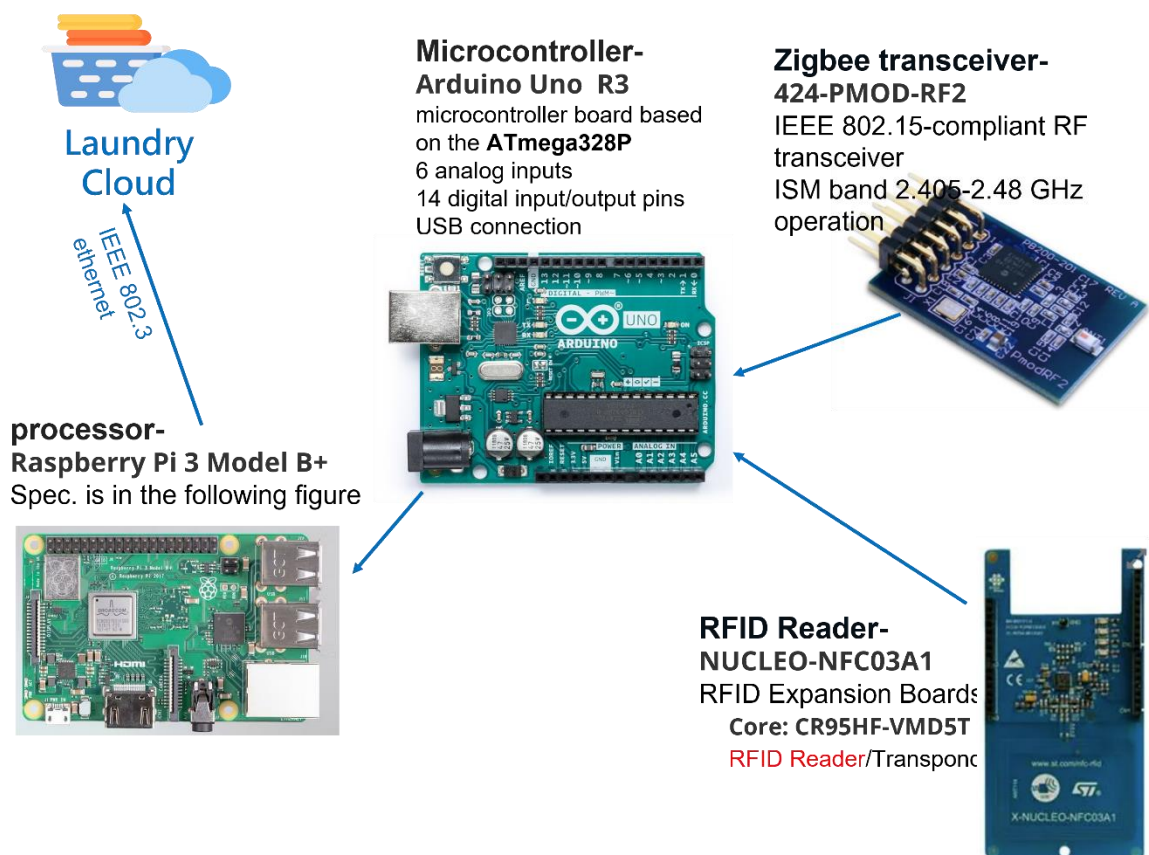


Figure 11, hardware of Smart Washer/Dryer

Raspberry Pi 3 Model B+



Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz
1GB LPDDR2 SDRAM
2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE
Gigabit Ethernet over USB 2.0 (maximum throughput 300 Mbps)
Extended 40-pin GPIO header
Full-size HDMI
4 USB 2.0 ports
CSI camera port for connecting a Raspberry Pi camera
DSI display port for connecting a Raspberry Pi touchscreen display
4-pole stereo output and composite video port
Micro SD port for loading your operating system and storing data
5V/2.5A DC power input
Power-over-Ethernet (PoE) support (requires separate PoE HAT)

Figure 12, spec of Raspberry Pi 3 Model B+

2.3 Software – Client APP and Admin Board Web APP



Laundry Cloud has a complete hardware ecosystem, and also it has the Client APP and Admin Board web APP that can make the laundry more convenience, smart and ECO friendly. With Laundry Cloud, customer can book the laundry or dryer machine in APP online. If the scheduled time is up, the user will be notified via APP. Moreover, customer can

be auto schedule when to do laundry via APP with Laundry Cloud AI model. It will consider the big data of all user's schedule, whether or other internal or external parameters and make a best decision for user when to do laundry can save the most time. Also, the clothing washing guideline is included in client APP that can make customer more understand how to wash and protect the clothing.

The payment and bonus points can be do and store online and instantly, in the future, there is no need for customer to saving pocket money just for laundry, Line Pay, Apple Pay, Android Pay, Credit card is support for online payment. Also, we have the bonus points for discount and promotion.

With the IoT Device, big data and well platform, the energy usage can be well monitored and predicted. Laundry Cloud want to combine with the ESG Spirit, the ECO Friendly solution can help the industry and government have more power on controlling and motoring the water, electricity and even GAS usage and save the energy.



For laundry time predictable, not just tell you what time the laundry is finish, but also tell you when to do your laundry base on the big data analyze and AI model predict. With Laundry Cloud and client APP, customer can really experiment the ideal laundry procedure due to the smart schedule feature.

Through AI and big data prediction, Laundry Cloud can let users know how long it will take to do laundry, so that users can freely schedule their laundry time without misjudging or

wasting other waiting time. In addition, users can get advice and knowledge about laundry in the app, which not only makes laundry more time-saving, but also ensures that clothes will not be damaged.



Reservations & Notifications

Know when to laundry, know when to finish.



Notification

When finish, APP will notify you instantly



Reservations

Book the laundry & drying machine. Easy to schedule.

When the laundry or dryer is finish, the client APP will instantly notify the customer. Moreover, when the Laundry Cloud AI predict the data and time is suitable for customer to schedule to do laundry. Laundry Cloud will notify customer whether the time is free and good for laundry. If the decide to reservation and machine. Cloud will help it schedule the ideal thread and procedure to do the laundry for saving time.



Mobile Payments & Bonus Points

Do more laundry more cost-effective



Mobile Payment

Pay by Line Pay, Apple Pay, Android Pay, or your credit card secure and instance



Bonus Points

Every laundry can earn bonus points, it can use for discount on next laundry payment.

When talk about the payment, in traditional way, customer need to pay with the nickel, even have to change the nickel to pay the laundry machine. With Laundry Cloud client APP, user can pay with Apple Pay, Line Pay, Android Pay or even credit card. There is no need to save the changes just for pay for the machine. For laundry owners, no money in machine in no man shop is more secure and can't prevent some robbery problem.



For laundry shop owners, the management is the big problem. The situation getting worse if the laundry shop is unmanned store, the managers cannot tell the customer. With Laundry cloud, customer can be management online, store manager can easily know the customer info even it is the unmanned laundry store. Moreover, Admin board can let the manager manage billing, Device, Machine and emery usage report. In the future, running the laundry shop will be more easily and precisely.

2.4 Laundry Cloud

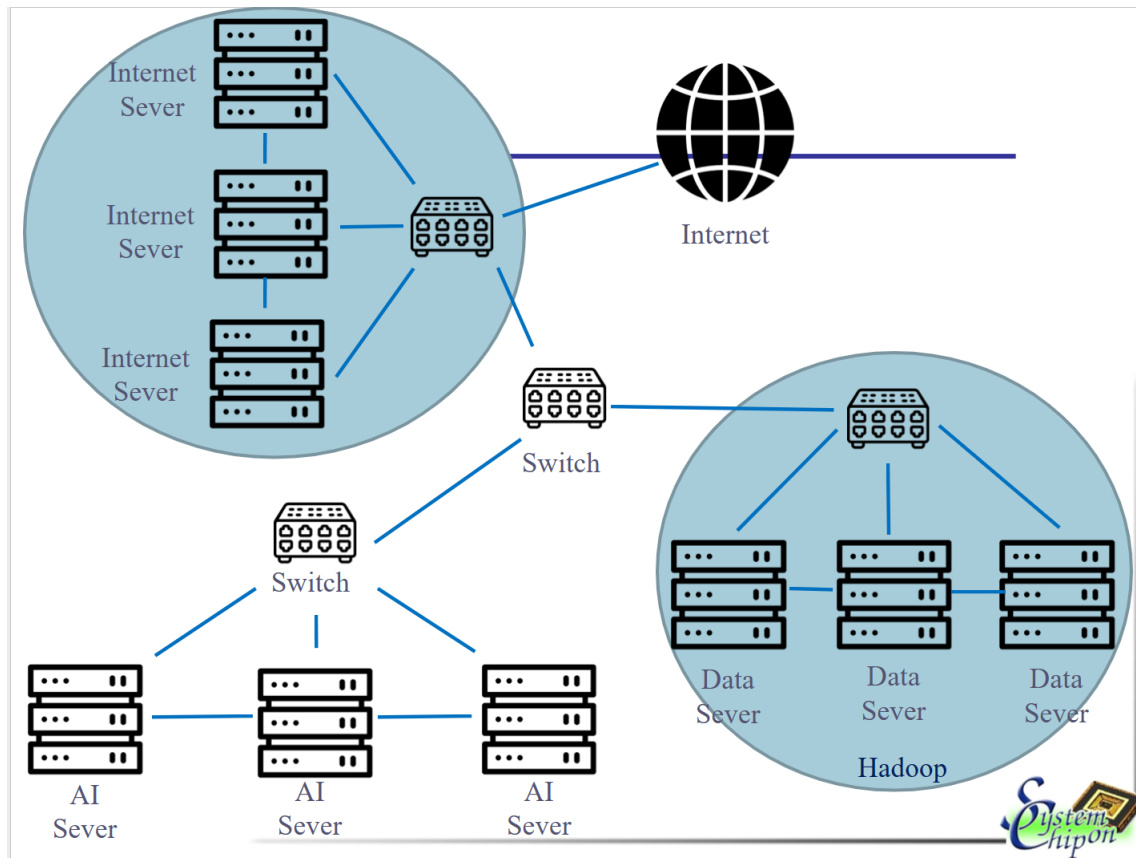


Figure 13, Structure of Laundry Cloud

Our Laundry Cloud contains three types of servers, shown as Figure 13. It contains three clusters of servers, which are Internet Server, Data Server and AI Server. Each cluster connects with other clusters via switch. The Internet Cluster also connects to the Internet, while others don't for security concerns.

2.4.1 Internet Server

The main function of Internet Server is shown as the following:

- (1) Transfer the messages sent from smart washers, smart dryers and hangers to clients' smartphones.
- (2) Support electronic payment.
- (3) Support function of our app.
- (4) Smart dryer, smart washer reservation.

Since the functions require server to set up tens of thousands of connect, the server must be

powerful to handle it. Therefore, we select Gigabyte R282-NO0 Server to form the server cluster.

The following is the features of R282-NO0

- (1) Intel Xeon W series, up to 38 cores 76 threads per CPU
- (2) Supports GRAID SupremeRAID NVMe/NVMe-oF RAID Card
- (3) 3rd Gen. Intel® Xeon® Scalable Processors
- (4) 8-Channel RDIMM/LRDIMM DDR4 per processor, 32 x DIMMs
- (5) Supports Intel® Optane™ Persistent Memory 200 series
- (6) Dual ROM Architecture supported
- (7) Intel® C621A Chipset
- (8) 2 x 1Gb/s LAN ports (Intel® I350-AM2)
- (9) 1 x Dedicated management port
- (10) 24 x 2.5" Gen4 NVMe hot-swappable SSD bays
- (11) 2 x 2.5" SATA/SAS hot-swappable HDD/SSD bays in rear side
- (12) 2 x PCIe Gen4 x16 expansion slots
- (13) 1600W (240V) 80 PLUS Platinum redundant power supply
- (14) Use OCP 3.0 high speed network adapter, such as E810-XXVDA2
- (15) Or PCIE 3.0 high speed network adapter, such as X710-DA4



Figure 14, 710-DA4



Figure 15, E810-XXVDA

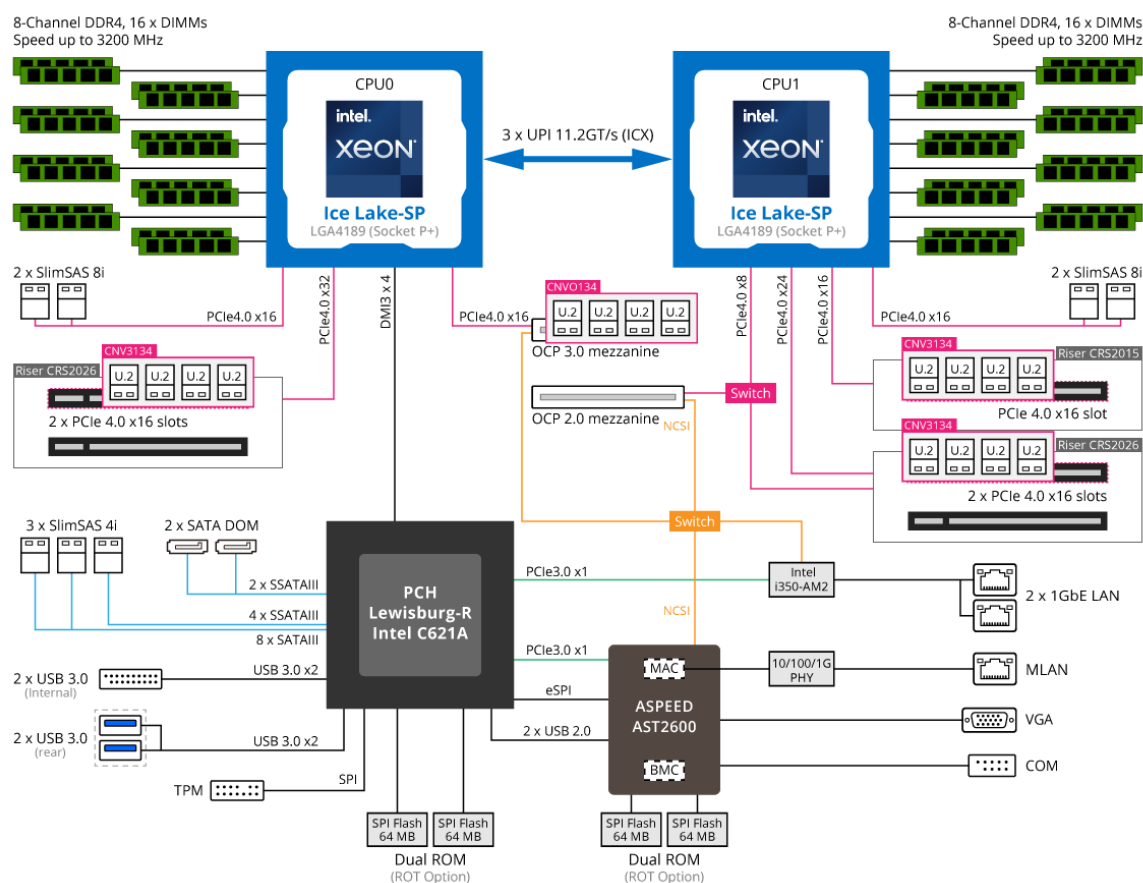


Figure 16, Block Diagram of R282-NO0

As we can see, R282-NO0 contains two CPU slot and 2 * (8 channel DDR4, 16 DIMMs) memory, which can be up to 1 TB RAM per CPU. The 24 high speed NVMe SSD is large enough to cache the data. The additional PCIE 4.0 slot can install high speed Internet adapter

to support 25 Gigabit/s Internet connection. Therefore, our client can enjoy low delay and the smooth service provided by our servers.

2.4.2 Data Server

Data servers store the data of all clients, including history of payment, laundry schedule, account information and so on. The information is invaluable and extremely large. As a result, the data server cluster and server itself must have the following features:

- (1) Extremely Large Data storage.
- (2) Establish Data Redundancy.
- (3) Efficiency key-value search system.

The Gigabyte S452-Z30 Storage Server meets our demands. The followings are its features:

- Single AMD EPYC™ 7002 series processor family
- 8-Channel RDIMM/LRDIMM DDR4, 16 x DIMMs
- 2 x 1Gb/s LAN ports (Intel® I350-AM2)
- 1 x dedicated management port
- 36 x 3.5" SATA/SAS hot-swap HDD/ SSD bays
- 2 x 2.5" SATA hot-swap SSD bays
- 4 x 2.5" SATA/NVMe hybrid hot-swap SSD bays
- SAS expander with 12Gb/s transfer speed
- 2 x Ultra-Fast M.2 with PCIe Gen3 x4 bandwidth
- Up to 4 x PCIe Gen4 slots and 2 x PCIe Gen3 low profile slots
- Dual 1200W 80 PLUS Platinum redundant power supply

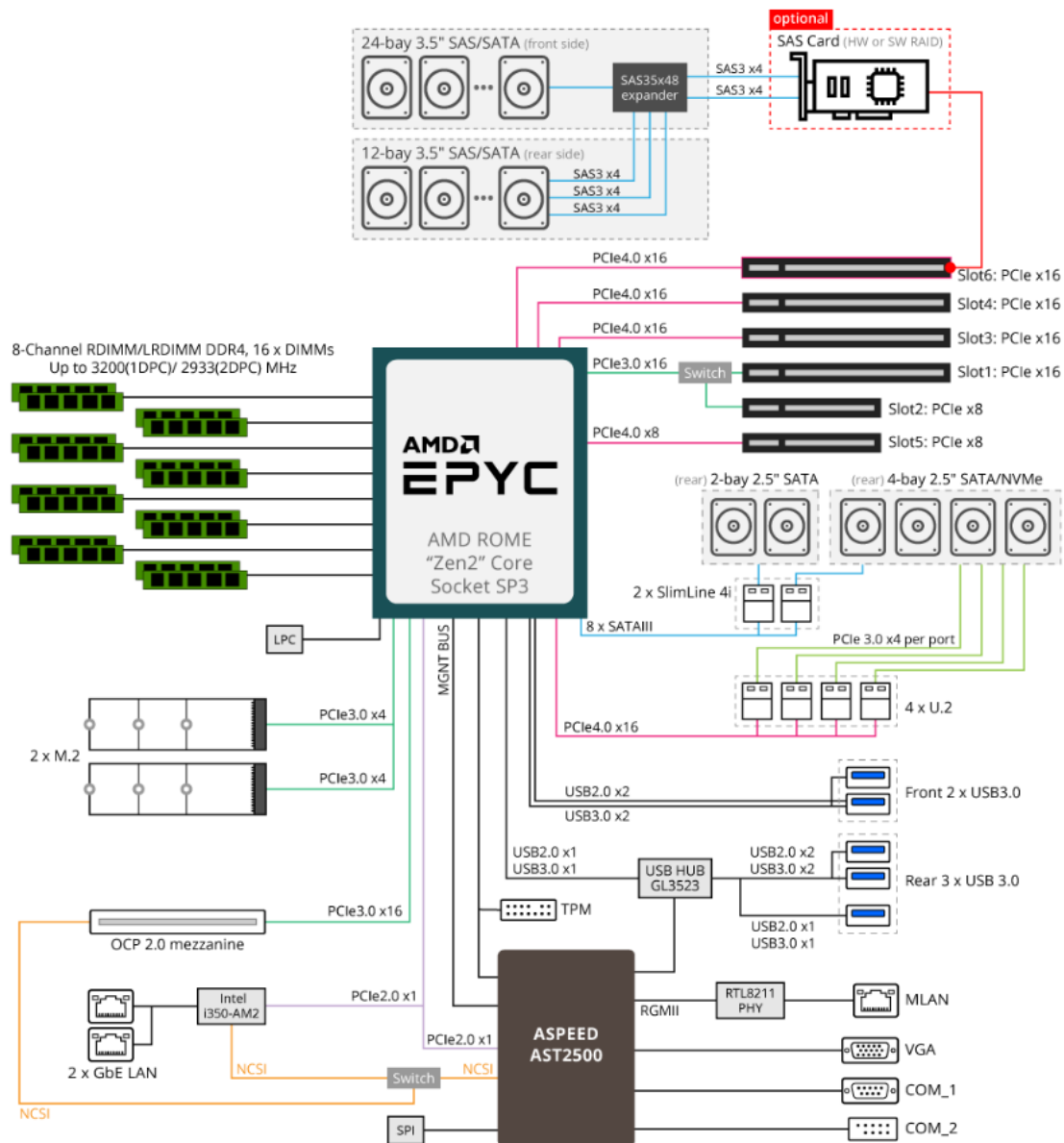


Figure 17, Block Diagram of S452-Z30

S452-Z30 owns 36 3.5" SATA HDD/SSD bays, which indicates that the maximum storage capacity is up to 63*20 TB for a single server. The addition 2.5" SATA/NVMe hybrid hot-swap SSD bays and up to 1 TB DRAM can be the cache of the database to speed up key-value storage. Gigabyte also provides some useful tools to monitor the operation. The Smart Crises Management / Protection (SCMP) protects the server and prevents it from accidentally shut down when encounter failure of power supply.

Although a single S452-Z30 server is very powerful, our clients' data are likely to reach thousands of TB or even up to Peta Byte. Moreover, if a single server encounters failure, some data will be lost and lead to bad service experience for clients. It is going to take lots of

time and money to recover this priceless data. Therefore, we introduce Hadoop Distributed File System (HDFS) to our data storage system. HDFS creates multiple copies for each file and scatters them to different servers and manages the whole server cluster. If a server is offline, the manage system can find another copy of data and create another copy for data redundancy, so the service is still working. Our clients still enjoy the low delay and smooth service.

2.4.3 AI Server

AI servers train several models to predict rush hour of the laundry, estimate the consumption of electricity, gas and water, and more importantly, the recommendation of laundry schedule.

To achieve this goal, the AI Server must have the following features:

- (1) Fast AI computation ability to train and run model
- (2) Good Internet transmit speed to receive training data
- (3) Large RAM and SSD/HDD to store training data

The NVIDIA DGX STATION A100 is a good option and meets our demands. Here is the spec of DGX STATION A100 :

SYSTEM SPECIFICATIONS		
	NVIDIA DGX Station A100 320GB	NVIDIA DGX Station A100 160GB
GPUs	4x NVIDIA A100 80 GB GPUs	4x NVIDIA A100 40 GB GPUs
GPU Memory	320 GB total	160 GB total
Performance	2.5 petaFLOPS AI 5 petaOPS INT8	
System Power Usage	1.5 kW at 100–120 Vac	
CPU	Single AMD 7742, 64 cores, 2.25 GHz (base)–3.4 GHz (max boost)	
System Memory	512 GB DDR4	
Networking	Dual-port 10Gbase-T Ethernet LAN Single-port 1Gbase-T Ethernet BMC management port	
Storage	OS: 1x 1.92 TB NVME drive Internal storage: 7.68 TB U.2 NVME drive	
DGX Display Adapter	4 GB GPU memory, 4x Mini DisplayPort	
System Acoustics	<37 dB	
Software	Ubuntu Linux OS	
System Weight	91.0 lbs (43.1 kgs)	
Packaged System Weight	127.7 lbs (57.93 kgs)	
System Dimensions	Height: 25.1 in (639 mm) Width: 10.1 in (256 mm) Length: 20.4 in (518 mm)	
Operating Temperature Range	5–35 °C (41–95 °F)	

Table 1, SPEC of DGX STATION A100

DGX STATION has 4 NVIDIA A100 GPU, one of the most powerful GPU now. With these GPUs connected with NVLink, the server can reach up to 2.5 peta FLOPS on AI training, 11x faster than previous version. The 7.68 TB Storage and the 512 GB can cache the mega training data. The 10Gbase-T Ethernet LAN provides high speed network to data server and access the training big data.

2.5 Scenario

In this section, we will show two scenarios of our system.

2.5.1 Reservation

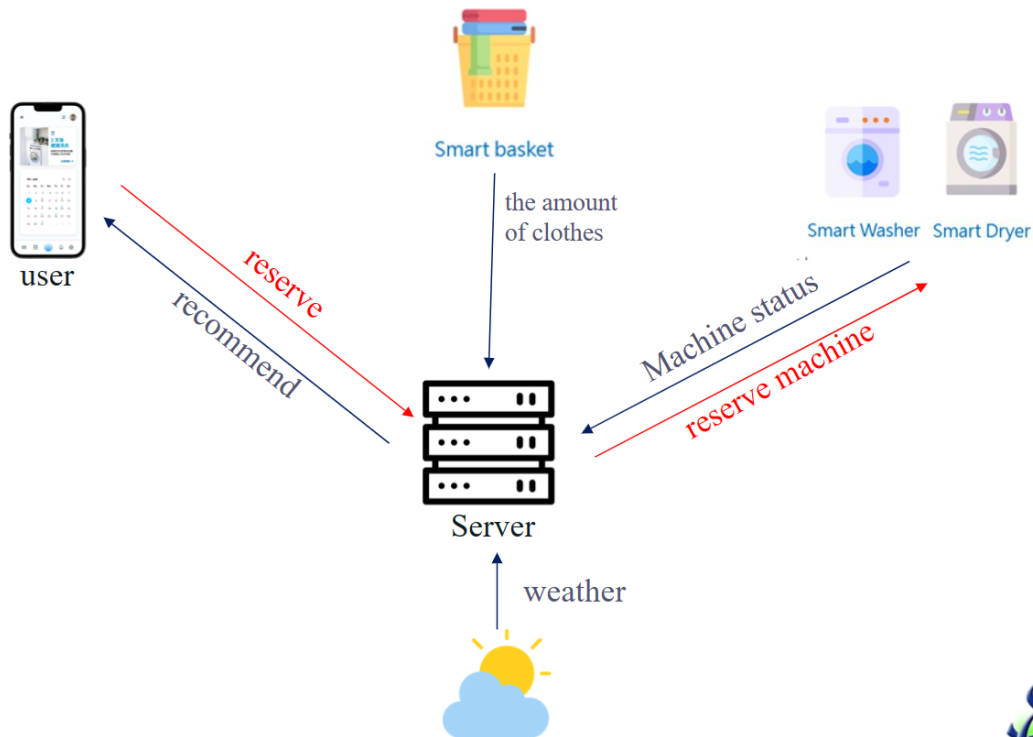


Figure 18, Reservation Data Flow

In the reservation process, a user can take the initiative to reserve a washer or dryer. Our Laundry Cloud receives the request and reserves the machine for users. However, users may encounter rush hour and therefore he or she cannot reserve a machine, or user sometime forget to wash his or her clothes. Therefore, our Laundry Cloud collects the amount of dirty clothes from Smart basket, the usage and the traffic information of Smart Washer and Smart Dryer, the weather information, and history of laundry traffic and user daily schedule. Then, the information will be the input of our AI model and generate recommendation of laundry schedule. All the users need to do is reserve the Smart Washer or dryer when our Laundry Cloud sends the recommendation.

2.5.2 Washing Process

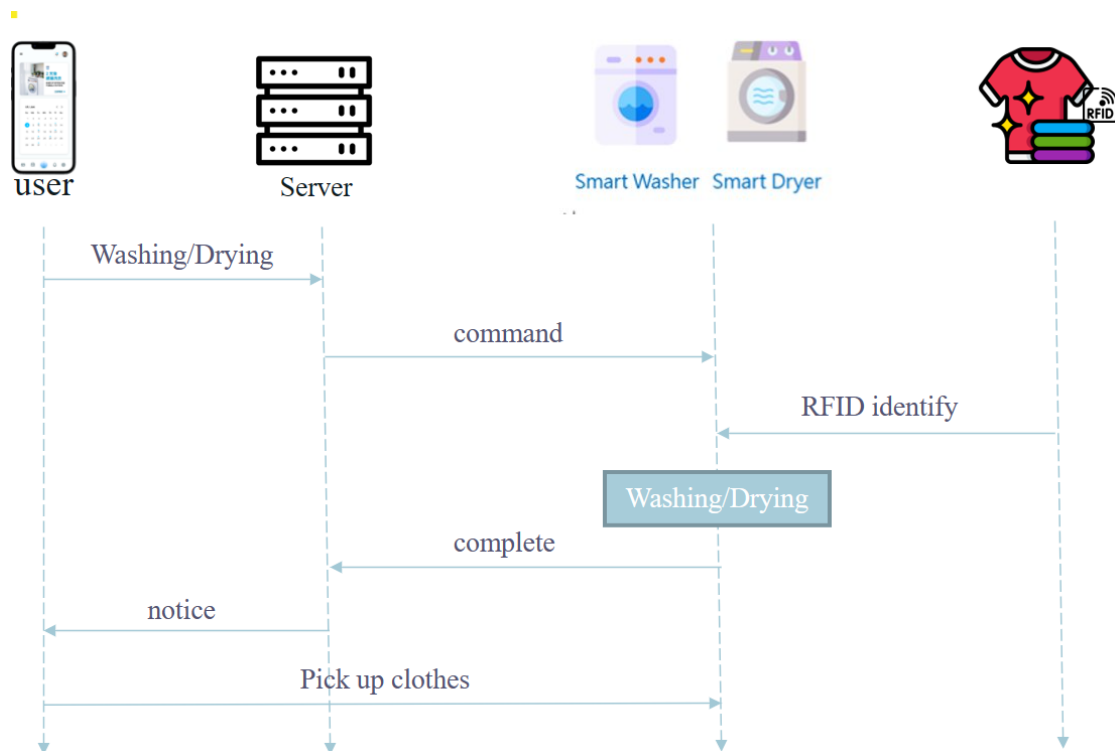


Figure 19, Washing/Drying process

After reservation, our Smart Washer and Smart Dryer will be locked on the reserved time. Our user uses our App on smartphone to check in, the machine will be unlocked, and the user can put their clothes with RFID containing the information of the clothes into the machine.

The Smart Washer and Dryer have RFID reader at the door of the machines. When putting the clothes into them, the reader reads the information, selects the proper washing process and correct amount of laundry detergent, fabric softener bleach, temperature and time. If there are some clothes that cannot be washed/dried together or should not be washed/dried, a warning message is generated to the user.

Near the end of the washing/drying, our Laundry Cloud will consider the washing/drying processing time and the traffic time of the user and inform the user the finish time and recommendation leaving time to pick clothes.

3. Market analysis

According to statics from 財政部不動產資訊平台, since March 2018, there have been 1,243 self-service laundromats in Taiwan. By March 2022, there will be 2,289 self-service

laundromats, an astonishing increase of 80% in four years. This shows that the laundromat industry is growing. And in 2020, in Taiwan, the value of the laundry industry including washing machines, commercial washing machines, self-service laundromats, and traditional laundries is about TWD 20 billion. Among these, the total output value of self-service laundromats is about TWD 10 billion, accounting for almost half of the total value of this whole laundry. As shown in Figure 20, it can clearly be noted that the number of self-service laundromats is increasing year by year.

自助洗衣店店數統計

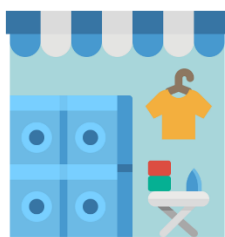
時間	新北市	臺北市	桃園市	臺中市	臺南市	高雄市	全國家數總計
107年 3月	149	177	217	186	65	128	1,243
108年 3月	179	194	232	230	73	153	1,422
109年 3月	208	211	243	266	96	179	1,644
110年 3月	236	233	268	295	191	225	1,977
111年 3月	271	248	298	335	229	280	2,289

資料來源：財政部統計資料庫

Figure 20, number of self-service laundromats in 6 cities in Taiwan

Market analysis: target market analysis

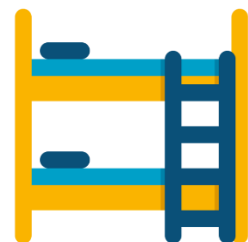
Smart Laundry is a completed system from each IoT devices and Laundry Cloud server to Laundry APP, so we have three main targets: for commercial used-laundry shops, for home use, and for school dormitories.



Laundry Shop



Home User



School Dormitory

Figure 21, three main targets

As shown in Figure 20, because number of self-service laundromats and its total output value both are increasing. That is, laundromat competition just got tougher. If using Smart Laundry system, it will be very convenient to manage, and the functions provided by smart laundry are

more attractive to consumers. Not only that, but school dormitories can also benefit from using this system. Students don't have to worry about whether the washing machine is available, and whether the clothes are dry or not. Smart Laundry is also suitable for households who can view and check their water and electricity usage using the Laundry App.

Market analysis: Competitor

Self-service laundry:

Self-service laundry is traditional laundry. Clients enter the shop, pick up an available washer/dryer and put their clothes in. Clients pay the bills via putting the coin into the machine, which is inconvenient sometimes. Moreover, sometimes Clients bring their clothing to the shop but cannot find any free machines to use. They need to waste their time just for waiting and doing nothing.

Fami 自助洗衣:

In recent year, Family 自助洗衣 is appeared. This is a self-service laundry of Family mart. Not like traditional self-service laundry, it has its own app to use. In that app, clients can see the status of machine and even can reserve the machine. It is able to avoid customers bringing clothes to the shop but no available machines. But it is still a problem. If there are many customers who want to use machines in the same period of time, it is likely that some of the customers do not have available machines to use. He/she has to wait, not knowing when it will be available. The Fami app do not provide recommend laundry schedule based on that time.

IoT home washing machine (Panasonic):

This is a household washing machine with Internet of Things, which can be connected to the customer's mobile phone through the APP. In the APP, users can monitor which stage the machine is in, such as washing, dehydrating, or finishing, and know what time the laundry done. And the IoT home washing machine can detect the weight of clothing putted in, and automatically put in the appropriate detergent. However, it still has the problem of not sending an alert if a customer does their laundry the wrong way, which may cause the clothing damaged.

Market analysis: Compare

As shown in Table 2, we compare our smart laundry room with others. Most of the services we list in the table are provided in our smart laundry room such as laundry reminder, automatic washing, laundry warning, notification (the clothes are sun-dried), recommend laundry scheduling (based on weather or traffic), and a reserve system, but others aren't.

Laundry reminder will notify users to do the laundry if the basket is full. Automatically washing that is based on each cloth RFID provides a suitable washing process. Laundry warning will remind you when you put the clothes which are belonging to different washing processes together. Our smart laundry provides the above services while others do not. Moreover, our smart washer can recommend a laundry schedule depending on weather and traffic which is seldom provided by other competitors. Overall, our smart laundry room provides several services that are rarely seen in the laundry market and they are helpful for the customers.

	laundry reminder	Automatically washing (based on each cloth RFID)	Laundry warning	notification (the clothes are sun-dried)	recommend laundry schedule (based on wether)	recommend laundry schedule (based on traffic)	Reserve system
Self-service laundry	✗	✗	✗	✗	✗	✗	✗
IoT home washing machine (panasonic)	✗	✗	✗	✗	✓	✗	✗
fami自助洗衣	✗	✗	✗	✗	✗	✗	✓
Smart Laundry (our)	✓	✓	✓	✓	✓	✓	✓

Table 2, Compare table.

4. Reference

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5. Task Partition

- **Introduction**

- Motivation and application: 施冠彰

- **System and structure**

- Hardware: 黃廉傑、許詠晴
 - Software: 施冠彰
 - Server: 張又仁
 - Application Scenario: all

- **Market analysis: all**

- **Organize report: all**

- **Presentation: all**