Architecture Design for Retail Chain Shop

To fulfill the requirements of the IASA Student Architecture Competition

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Date: September 15, 2016

Introduction

Enhancement of customers' shopping experience is key to expansion of any business. Gartner have considered customer experience as 'new competitive battlefield' [1]. Gartner also reported a 5% increase in global same store sales for McDonald's, by considering and improving customer experience[2]. We take inspiration from such evidence and observe the necessity of designing a software system that will enhance shopping experience of customers in a typical regular store. We also consider the importance of buyer persona, a concept that helps to improve customer experience[3]. Octopus Group[4] has reported that they have increased revenue from inbound marketing by 30%, using buyer or customer persona. In this proposal we provide a software architecture that can enhance customer experience using cloud-based technologies keeping a customer-based persona, in perspective. We assume a hypothetical regular retail chain store shop and focus on using the concept of persona i.e. creating customer profiles based on recording customer habits as well as analyzing existing customer data. Our proposal also takes involvement of personnel management into account to facilitate better customer experience. Our proposal includes a conceptual architecture, as well as other architectural concepts that discuss the feasibility of our implemented approach. While designing our software system we consider the aspects of scalability, applicability, security of end-user data, and cost of implementing the system. In our discussion of each categories of architecture we provide a hypothetical example of a persona, and show how the proposed architectures can be used to fit the persona. We present the highlights of our proposal as following:

- Architecture proposal of software that discusses infrastructure, information architecture, security architecture, software architecture, and conceptual architecture
- The proposed architecture focuses on customer persona to improve customer experience
- The proposed architecture relies on cloud-based services to ensure reliability, security, and economic benefits
- The proposed architecture leverages open source technologies to facilitate economic benefits

We organize this proposal as following: Section B provides the conceptual architecture. Section C provides the information architecture. Section D provides the security architecture to discuss the software stack used for the proposal. Section E we discuss the security architecture of the proposal. Section D provides the security architecture to discuss the software stack used for the proposal

[1] http://www.gartner.com/smarterwithgartner/test/
[2] http://blogs.gartner.com/augie-ray/2016/01/26/mcdonalds-turnaround-customer-experience-success/
[3] http://tonyzambito.com/buyer-personas-important/
[4] http://www.weareoctopusgroup.net/how-we-increased-revenue-from-inbound-marketing-by-30/

Section B: Conceptual Architecture

In this section we provide the high level view of our proposed solution in Figure 1. Our proposed solution will include software and hardware components as shown in Figure 1. We describe each component briefly as following:

Hardware:
The hardware components that will be used for our solution are:

1. Mobile devices: Customers that don't have their personal devices will use the company provided mobile devices. Additionally, the employees will also have mobile devices for store management.
2. Wi-Fi router: Public Wi-Fi will be made available to the customers using Wi-Fi routers
3. Kiosk: Tablet-type devices will be used to scan bar codes and provide customers' receipts.

Software:

1. UI: The user interface for the apps for customers, employees, and for the kiosk will be different to each other. The app for customer will be generated based on customer persona, and will vary from one customer to another. On the other hand, the UI for employees will be generated based on employee role such as store manager, cashier, or inventory manager. In short, UI will be the interface that communicates with customers and employees, hiding details of implementation and business logic.
2. Storage: The transactions made by all customers, in all stores for the regular retail chain store will be stored in a cloud-based storage system. The addition, deletion, and update of records related to inventory, and employees will also be stored in a cloud-based storage system.
3. Data Analysis: This software module will analyze transaction data to generate customer-shopping patterns, make inventory management recommendations, and analyze in-store customer activity data, using the concept of big data applications. Machine learning techniques such as deep learning and frequent item set mining will be used upon bulk customer transaction data, as well as inventory management data.
4. Third party data sources: We consider any data source not belonging to the store or customers as third party data sources such as weather data, event calendars API, and customer profiles of other vendors. The proposed solution will use third party data sources to create customer personas offline. These personas will be used for new customers, to create promotions, and updated accordingly in conjunction with transaction data and customer activity data. The data analysis component will analyze third party data.
5. Monitoring: This software module will track the status of cloud-based services, and the devices used in the proposed architecture.

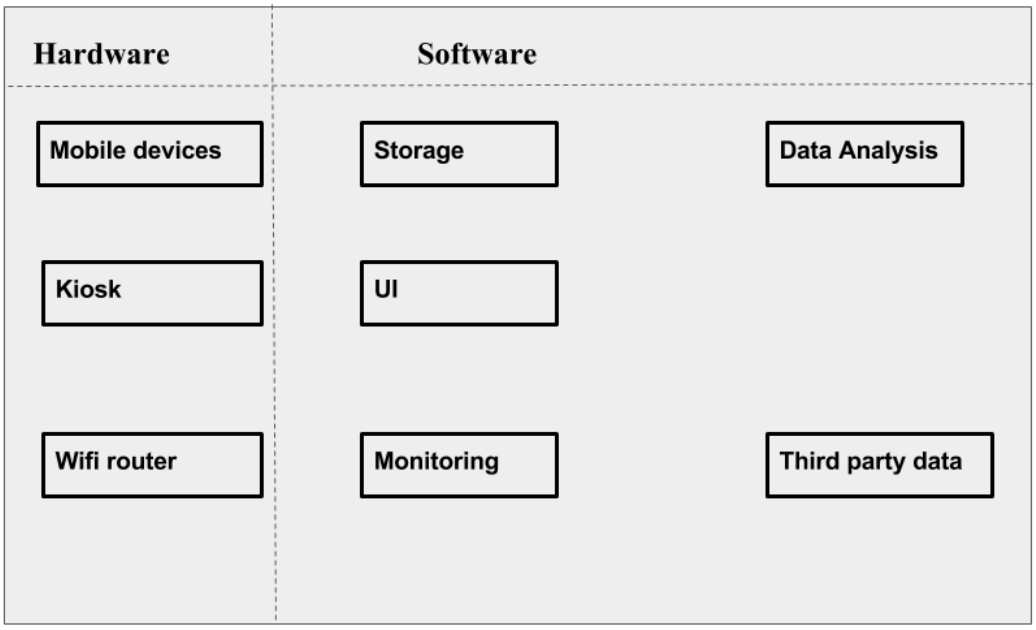

Figure 1: Conceptual architecture of the solution

Now we provide an example persona which we later to use to explain how the created persona maps with the conceptual architecture.

Persona-1: New Customer
Scenario-1
An individual walks in the store for the first time. The store aims to identify this individual as a new customer and make him/her as a regular customer. The possible actions to achieve this goal can be presented as:

- As soon as the individual steps in, the Wi-Fi asks him/her to join
- Joining the Wi-Fi requires to download and install the store app
- Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the individual's input.
- Upon registration the individual will get a promotion code
- The app will be adjusted based on the customer's' profile
- The individual's traversing of the store can be tracked via the Wi-Fi footprints
- Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances.
- Upon checkout, data will be send to storage

In Table 1, we mapped the actions to the components of the conceptual architecture

Table 1: Mapping of scenario-1 to components of the conceptual architecture

Action	**Component**
As soon as the individual steps in, the Wi-Fi asks him/her to join	Wi-Fi router
Joining the Wi-Fi requires to download and install the store app	UI
Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the individual's input.	Data analysis Employee's mobile phone Third party data sources
Upon registration the individual will get a promotion code	Data Analysis UI
The app will be adjusted based on the customer's' profile	Data Analysis UI
The individual's traverse of the store can be tracked via the Wi-Fi footprints	Storage Wi-Fi router
Customer buys products	Storage UI
Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances.	Data Analysis Storage UI
Upon checkout, data will be send to storage	Storage UI

Persona-2: Existing Customer
Scenario-1
Existing customer, who likes beer, walks into the store. The store wants to present the most relevant products to the individual and where the products can be found. The assumption here is

the person uses deals to buy the beers he/she wants. The possible actions to achieve this goal can be presented as:

- As soon as the individual steps in, the app makes an alert
- Upon opening of app, the customer gets notified on beer deals and the corresponding aisles, where the deals are located
- Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with relevant products and the aisles where they are located.
- The individual's traversing of the store can be tracked via the Wi-Fi footprints
- Customer buys products
- Track which of the relevant items customer bought and which items were ignored

Table 2: Mapping scenario-2 to components of conceptual architecture

Action	**Component**
As soon as the individual steps in, the app makes an alert	Data Analysis, UI
Upon opening of app, the customer gets notified on beer deals and the corresponding aisles, where the deals are located	UI
Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with relevant products and the aisles where they are located.	Data analysis, UI
The individual's traversing of the store can be tracked via the Wi-Fi footprints	Wi-Fi Router, Storage, UI
Customer buys products	UI, Storage
Track which of the relevant items customer bought and which items were ignored	UI, Storage, Data Analysis

Section C: Information Architecture

Information architecture presents the flow of the information within the software system. We use entities to express how information flows within our system. An entity is an abstraction of a piece of information that requires being stored as a record. We first present the entities and then present the information flow in Figure 2.

Table 3: Entities involved in the information architecture

Entity	**Attribute**
Customer	ID, Password, Email, StartDate, TerminationDate, Gender, PaymentID, DeviceID, PersonaID
Item Category	ID, Category Name, ItemID, AisleID
Items	ID, Title, ItemAmountExisitng, ItemAmountChangedTime, ItemFirstAdded, Picture, BarcodeID, CategoryID, Location, Price
Kiosk	ID, StoreID
Payment	ID, Type, Details
Promotions	ID, CustomerID, Amount, ItemID
Shopping Cart	ID, ItemID, ShoppingCartAmount, Timestamp
Store	ID, LocationID, KioskID
Transaction	ID, CustomerID, CartID, PromotionID, FinalAmountPaid, KioskID, UniqueCode, PaymentID, DeviceID, Timestamp
Wi-Fi Footprint	ID, Timestamp, CustomerID, Store ID
Wishlist	ID< ItemID, Listname, Timestamp

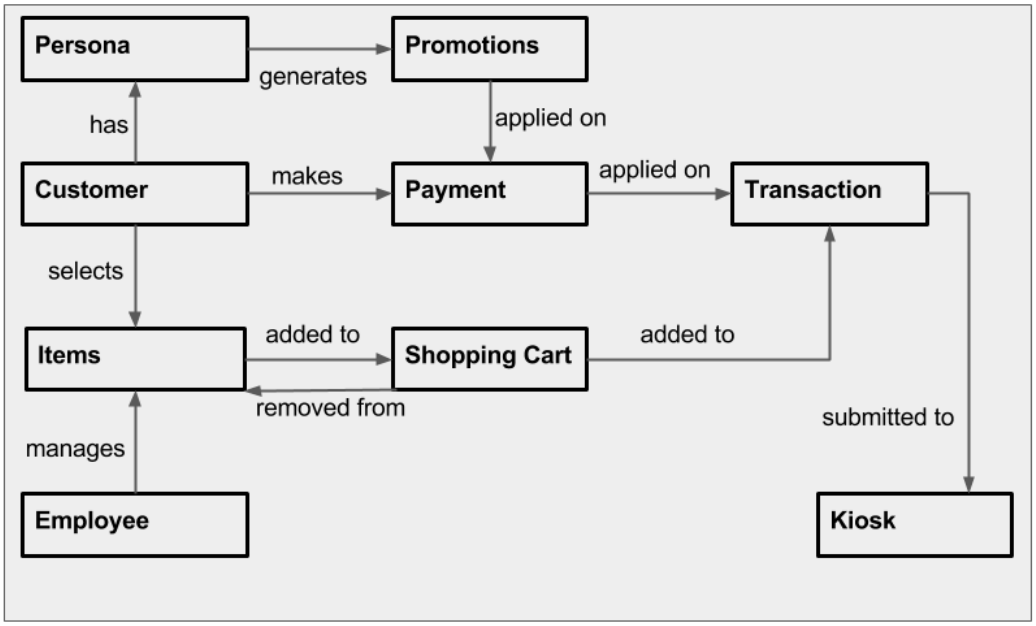

Figure 2: Information architecture of the system

In Figure 2, we see how the entities interact with each other. For example, the 'Customer' entity makes a selection of 'Items'. These 'Items' are added to 'Shopping Cart' that is later to a 'Transaction' entity.

Now we provide an example scenario that we later use to explain how the created persona maps with the information architecture.

Persona-1: New Customer
Scenario-1
An individual walks in the store for the first time. The store aims to identify this individual as a new customer and make him/her as a regular customer. The possible actions to achieve this goal can be presented as:

- As soon as the individual steps in, the Wi-Fi asks him/her to join
- Joining the Wi-Fi requires to download and install the store app
- Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the individual's input.
- Upon registration the individual will get a promotion code
- The app will be adjusted based on the customer's' profile
- The individual's traversing of the store can be tracked via the Wi-Fi footprints

- Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances.
- Upon checkout, data will be send to storage

Table 4: Mapping of scenario-1 with entities

Action	**Entity**
As soon as the individual steps in, the Wi-Fi asks him/her to join	N/A
Joining the Wi-Fi requires to download and install the store app	N/A
Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the individual's input.	Customer, Persona
The app will be adjusted based on the customer's' profile	Customer, Persona
The individual's traversing of the store can be tracked via the Wi-Fi footprints	Customer
Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances	Customer, Shopping cart, Transaction, Payment, Promotions
Upon checkout, data will be send to storage	Customer, Transaction

Persona-2: Existing Customer
Scenario-1
Existing customer, who likes beer, walks into the store. The store wants to present the most relevant products to the individual and where the products can be found. The assumption here is the person uses deals to buy the beers he/she wants. The possible actions to achieve this goal can be presented as:

- As soon as the individual steps in, the app makes an alert
- Upon opening of app, the customer gets notified on beer deals and the corresponding aisles, where the deals are located
- Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with relevant products and the aisles where they are located.
- The individual's traversing of the store can be tracked via the Wi-Fi footprints
- Customer buys products
- Track which of the relevant items customer bought and which items were ignored

Table 5: Mapping of scenario-2 to entities

Action	**Entity**
As soon as the individual steps in, the app makes an alert	Customer
Upon opening of app, the customer gets notified on beer deals and the corresponding aisles, where the deals are located	Customer, Items, Promotions
Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with relevant products and the aisles where they are located.	Customer, Items, Shopping cart
The individual's traversing of the store can be tracked via the Wi-Fi footprints	Customer, Items
Customer buys products	Customer, Shopping cart, Transaction, Payment
Track which of the relevant items customer bought and which items were ignored	Items, Customer, Shopping cart, Transaction

Section D: Security Architecture

Bringing all the shopping experience online means bringing a lot of digital data into picture and maintaining it. Given a set of data a system has to take care about the generation of data, its origin, validity and association with the users. Each of these aspects are important to the business, and they try to make every possible use of technology to maintain that. However, one of the important aspects of data that needs to be considered is the data security.

Data Security if considered during designing of any software or software infrastructure helps to reduce the later costs of implementations higher above the layers. The order or the preferences in which the security must be applied to a system must consider the People i.e. the users of the system first, then the Policy i.e. the security, access and authorization policies and then the Technology used.

Security Preference Order:

People → Policy → Technology.

The entity of users/people are the unit entities to secure, regardless of the policies and technologies implemented it is always a good practice to secure any data associated with them. The reliability of securing these entities can then be independent of technology. Since, technology can change or the data can migrate from one platform to another, implementation of security processes also need to be revisited if the security measures are applied at Technology layer.

In a retail market environment, as discussed earlier in Section 1 and 2, some of the important entities that are required to be secured is the data associated with the User, Inventory, Payment, and stores.

As discussed in the previous section, more priority is given to user security. Following are some of the properties of the User for which different levels of security measures are applicable.

Table 6: User properties and security requirements

Properties	**Security Requirements**	**Advantages**
User credentials: Username, Password, Security Questions, Verification entities	Need to store them using encryption, for integrity purpose can store the hash of all data combined.	Encryption: Securing the contents. Hashing: Data integrity.

Payment Info: Credit/Debit Card Number, Bank Account Details	Need to store them separately on different storage location, isolated using network fragmentation, and applying strict firewall rules. Encryption and Hashing.	Isolated Storage: Protection from any breaches leading to leakage of user information. Encryption: securing contents Hashing: Data Integrity

According to the specifications and recommendations given by the PCI Data Standard (PCI-DSS), in the digital retail sector, the payment information of any user should not be stored together along with his/her other data.

Implementation
According to PCI-DSS standards[5] the algorithms used to encrypt data can be asymmetric or symmetric, and emphasizes on rotational lifetime for the algorithm.
The proposed solution also considers the 11 requirements[6] for secure design that will be a part of the information architecture. Some of the fundamental requirements are:

- Maintain and use a firewall to protect customer data
- No use of system provided password defaults
- Protect the stored cardholder data
- Transmission of card data must be encrypted over public networks
- Installation and update of antivirus programs within the architecture

In the next subsection we use an example scenario, and show how the proposed security architecture will come into play:

Persona-1: New Customer
Scenario-1
An individual walks in the store for the first time. The store aims to identify this individual as a new customer and make him/her as a regular customer. The possible actions to achieve this goal can be presented as:

- As soon as the individual steps in, the Wi-Fi asks him/her to join
- Joining the Wi-Fi requires to download and install the store app

[5] https://www.pcisecuritystandards.org/
[6] https://www.pcisecuritystandards.org/pdfs/pci_ssc_quick_guide.pdf

- Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the individual's input.
- Upon registration the individual will get a promotion code
- The app will be adjusted based on the customer's' profile
- The individual's traversing of the store can be tracked via the Wi-Fi footprints
- Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances.
- Upon checkout, data will be send to storage

Table 7: Mapping of scenario-1 with security actions

Action	**Related security action**
As soon as the individual steps in, the Wi-Fi asks him/her to join	Maintain secure Wi-Fi signals within store
Joining the Wi-Fi requires to download and install the store app	Maintain secure Wi-Fi signals within store
Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the individual's input.	Required personal information of customer will be sent over an encrypted mechanism
The app will be adjusted based on the customer's' profile	Required personal information of customer will be sent over an encrypted mechanism
The individual's traversing of the store can be tracked via the Wi-Fi footprints	Required personal information of customer will be sent over an encrypted mechanism
Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances	Required personal location information will be encrypted while sending over the public network Customer's payment information will be

	secured over the network
Upon checkout, data will be send to storage	Required personal location information will be encrypted while sending over the public network

Persona-2: Existing customer
Scenario-2
Existing customer, who likes beer, walks into the store. The store wants to present the most relevant products to the individual and where the products can be found. We assume that the customer relies on deals to buy the beers he/she needs. The possible actions to achieve this goal can be presented as:

- As soon as the individual steps in, the app makes an alert
- Upon opening of app, the customer gets notified on beer deals and the corresponding aisles, where the deals are located
- Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with relevant products and the aisles where they are located.
- The individual's traversing of the store can be tracked via the Wi-Fi footprints
- Customer buys products
- Track which of the relevant items customer bought and which items were ignored

Table 8: Mapping of scenario-2 to infrastructure

Customer action	**Related component of the security architecture**
As soon as the individual steps in, the app makes an alert	Required personal information of customer will be sent over an encrypted mechanism
Upon opening of app, the customer gets notified on beer deals and the corresponding aisles where the deals are located	Required personal information of customer will be sent over an encrypted mechanism
Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with	Required personal information of customer will be sent over an encrypted mechanism Required personal location information will

relevant products and the aisles where they are located.	be encrypted while sending over the public network
The individual's traversing of the store can be tracked via the Wi-Fi footprints	Required personal location and router signal information will be encrypted while sending over the public network
Customer buys products	Required personal location information will be encrypted while sending over the public network Customer's payment information will be secured over the network
Track which of the relevant items customer bought and which items were ignored	Required personal information of customer will be sent over an encrypted mechanism

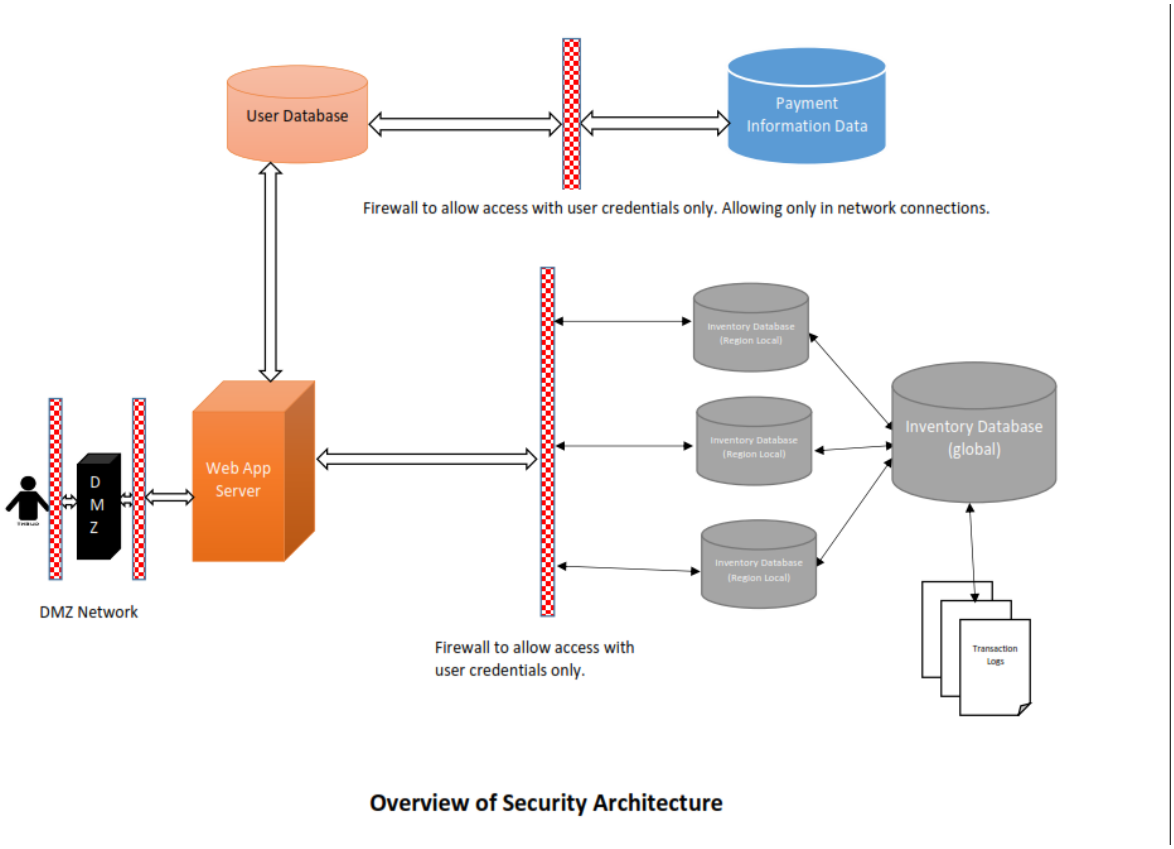

Figure 3: Overview of the security architecture

In this architecture, we will be hosting the data and services on a cloud service provider, for e.g. Amazon AWS. Service providers like Amazon AWS have various types of servers mainly compute servers, database hosting servers, analytics performing machines etc. Based on the demands of the server the different servers can be hosted.

Within such cloud service providers, it is necessary to have full control to set up network infrastructure between various such components. Network Fragmentation must be possible so as to isolate certain data servers and analytic servers from access by any normal users. As indicated above, the payment information must be stored on a different database server, with network fragmentation activated. Also, set firewall rules so that only authorized requests are made to it originating from within the network.

Some basic security checks that are required to be implemented can be enlisted as follows:

- A role with minimal access to system.
  Such role can be assigned to any new customer signing up to the app. Further, based on the profile he choses; extra role permissions can be added.
- There should be no Default system and application password configured.
- Whenever possible try to store data in an encrypted format, with keys being stored in a secured location and accessible only to limited people.
- Extra layer of protection to Payment Information Details.
- Configuring system and OS level security measures.
  Based on roles, the user must have read, write, and execute permissions for the files on system.
- Keep all the OS patches, Firewall rules, Anti-virus software updated.

User Devices Policies:

The application will be enforcing a single device - single sign-on policy. Hence, when a user registers from a particular device, he will able to login to the app only through that device. An exception to that is he can also be able to login into a in-store PDA, if user has no access to his/her personal device.

To allow us to enforce this policy, we will be required to store unique device identifiers and verify the login. These unique identifiers can be IMEI number, MAC address.

Any data stored on the device must be accessible using the app interface only. Hence, to protect the integrity and validity of the data generated, the app generated data must be stored in encrypted format and also hash value to verify the integrity.

Network Communication:

The data servers and application servers will be hosted in a cloud service provider infrastructure. Since, there are number of components which participate, any communication taking place between these servers must be secured.

Implementation of IPSec at network layer to protect eavesdropping on data exchanged and to maintain secrecy and integrity of the data exchanged.

User end devices must also have capability to connect to the server over the IPSec or use of TLS/SSL based transport protocol to exchange the data.

To allow only authenticated users to access the servers, all devices, including the user PDAs, store employees, management devices and kiosks must be whitelisted so that only known and registered devices in the network can access the data.

Section E: Infrastructure architecture

The store will require a lot of Infrastructure to support the massive scale of its functioning and processing its customers and products and keeping track of everything in relation to the store. If the store were to set up a private Infrastructure, it would require a lot of initial investment towards buying and provisioning and maintaining all the hardware required for the infrastructure. In this report we propose a cloud-based infrastructure that will facilitate the storage and analytics in real-time. Existing companies such as Adobe, Comcast, and Netflix, are using AWS-based cloud services to meet their needs.

We suggest the usage of public cloud options like Amazon AWS to reduce the complexity of hardware maintenance. The Public cloud option takes away a lot of initial investment and channels it into smaller monthly payments towards the cloud service provider and the details of the configuration and maintenance is abstracted for the user.

The store will require some infrastructure in the form of kiosks and handheld devices that the stores may lease out for the customers to use. The stores will require Wi-Fi access points throughout the store location to provide strong Wi-Fi connection for the customers throughout the store. Internet connection is one other major part of the infrastructure that needs to be enabled from an Internet Service Provider. The store should also have a backup of 4G-LTE Internet connections for cases of disasters of any form.

Firewall servers also need to be set up locally in all the stores to secure all the devices connected to the store's private network.

Screens and monitors can be placed across the stores to advertise for products and offers. These monitors can be coupled with face, feature or motion detecting cameras that can be used to personalize the advertisements being displayed on the screens. Retina tracking cameras can help determine which products are getting noticed more and that may help the manufacturers by focusing more on those products[7]. Motion tracking cameras can help in detecting the movements of the customers and help in detecting which items the customers prefer over others and the locations where the customers frequent. These observations can help in restructuring the store by moving the products around for better visibility by the customers[8].

Cameras can be installed near the kiosks and the checkout counters to detect the number of people in line. If the line increases, accordingly more kiosks or counters can be made operational. This will reduce the power consumption of the store by shutting down kiosks and counters during times of less customers, if any.

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[7] http://www.wsj.com/articles/SB10001424052702303644004577520760230459438
[8] http://www.businessinsider.com/how-retailers-track-shoppers-in-heat-maps-2014-1

The store will also need security cameras and theft detecting sensors at the exit to detect tags of products that were not removed.

To summarize our proposal we use a sample scenario and show how the proposed cloud-based infrastructure relates to that of customer persona.

Persona-1: New Customer
Scenario-1
An individual walks in the store for the first time. The store aims to identify this individual as a new customer and make him/her as a regular customer. The possible actions to achieve this goal can be presented as:

- As soon as the individual steps in, the Wi-Fi asks him/her to join
- Joining the Wi-Fi requires to download and install the store app
- Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the individual's input.
- Upon registration the individual will get a promotion code
- The app will be adjusted based on the customer's' profile
- The individual's traversing of the store can be tracked via the Wi-Fi footprints
- Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances.
- Upon checkout, data will be send to storage

Table 9: Mapping of scenario-1 with infrastructure

Action	**Infrastructure**
As soon as the individual steps in, the Wi-Fi asks him/her to join	Wi-Fi router
Joining the Wi-Fi requires to download and install the store app	Wi-Fi router
Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the	Wi-Fi router, Employee's mobile device, Firewall, AWS Storage and AWS EMR (Hadoop and Spark)

individual's input.	
The app will be adjusted based on the customer's' profile	N/A
The individual's traversing of the store can be tracked via the Wi-Fi footprints	Wi-Fi router, Firewall, AWS Storage
Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances	Wi-Fi router, (Hadoop and Spark)
Upon checkout, data will be send to storage	Wi-Fi router, Firewall, AWS Storage and AWS EMR (Hadoop and Spark)

Persona-2: Existing customer
Scenario-2
Existing customer, who likes beer, walks into the store. The store wants to present the most relevant products to the individual and where the products can be found. The assumption here is the person uses deals to buy the beers he/she wants. The possible actions to achieve this goal can be presented as:

As soon as the individual steps in, the app makes an alert

- Upon opening of app, the customer gets notified on beer deals and the corresponding aisles, where the deals are located
- Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with relevant products and the aisles where they are located.
- The individual's traversing of the store can be tracked via the Wi-Fi footprints
- Customer buys products
- Track which of the relevant items customer bought and which items were ignored

Table 10: Mapping of scenario-2 to the components of the infrastructure

Action	**Related component of the infrastructure**
As soon as the individual steps in, the app makes an alert	Wi-Fi router, Firewall
Upon opening of app, the customer gets notified on beer deals and the corresponding aisles, where the deals are located	Firewall
Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with relevant products and the aisles where they are located.	Wi-Fi router, Firewall, AWS Storage and AWS EMR (Hadoop and Spark)
The individual's traversing of the store can be tracked via the Wi-Fi footprints	Wi-Fi router, Firewall, AWS Storage
Customer buys products	Wi-Fi router, Firewall, AWS Storage and AWS Analysis
Track which of the relevant items customer bought and which items were ignored	Wi-Fi router, Firewall, AWS Storage and AWS Analysis

Section F: Software Architecture

Sometimes it is difficult for store shop to reach out to their customers in dynamic environment but powerful capabilities of today's mobile devices provide fertile ground for countless mobile application whether or not it is Android or iOS
So while building software architecture for store shop mobile application, we are taking following points into consideration

- Every component that we are planning to build will scale to large volumes without any performance degradations
- For store shop, we are expecting plenty of payment transactions, so the propose architecture will accommodate all the possible scenarios dynamic without any issues
- One of the main cruxes for any software system is to accommodate failures and design recovery system architecture to prevent that in future
- Content specific user engagement will be an important factor to be considered.
- Data driven decision making feature will help in building customer engagement and will in turn provide better results for store shop

Mobile applications can be developed in many ways but we are planning to go with the cross platform apps development where in application once developed can run on multiple mobile platforms (requires initial fine-tuning for each platform), making that application interoperable.

We are planning to make use of open source technologies wherever it's prudent.
The processing of the data needs to happen asynchronously throughout the system that will avoid single point of failure and will help in retaining and managing the data. We are planning to build loosely coupled system that will allow independent level component scaling.

Technology stack that we are planning to opt for store shop is

- Front End: Java, NodeJS, React, HTML5, CSS
- Server: Apache Zookeeper
- OS: Android, IOS
- Database: Hbase, MySQL, Mongodb, Solr
- Cloud/Hardware: Amazon AWS, S3, EC2,
- Data Analytics: Apache Storm, Google Offline Analytics, Apache Hadoop and Map Reduce

Mobile application should be as lightweight as possible so we will be creating simple POJO based application containers with HTML5 and CSS combination which will make it portable enough across multiple devices. One of the crucial parts that customers see when they install any mobile app is its user Interface and time it takes to load the data on the app. We have made sufficient arrangement to accommodate above requirement.

For centralized server and management of resources, we are taking help of Apache zookeeper. For data storage, we would be using multiple databases for streamlining the computing pattern when there is a huge amount of data received from the user.

This will be beneficial from the customer's point of view where time required fetching the product details and searching in the product catalogue would take less time and in turns helps in improving the user experience.

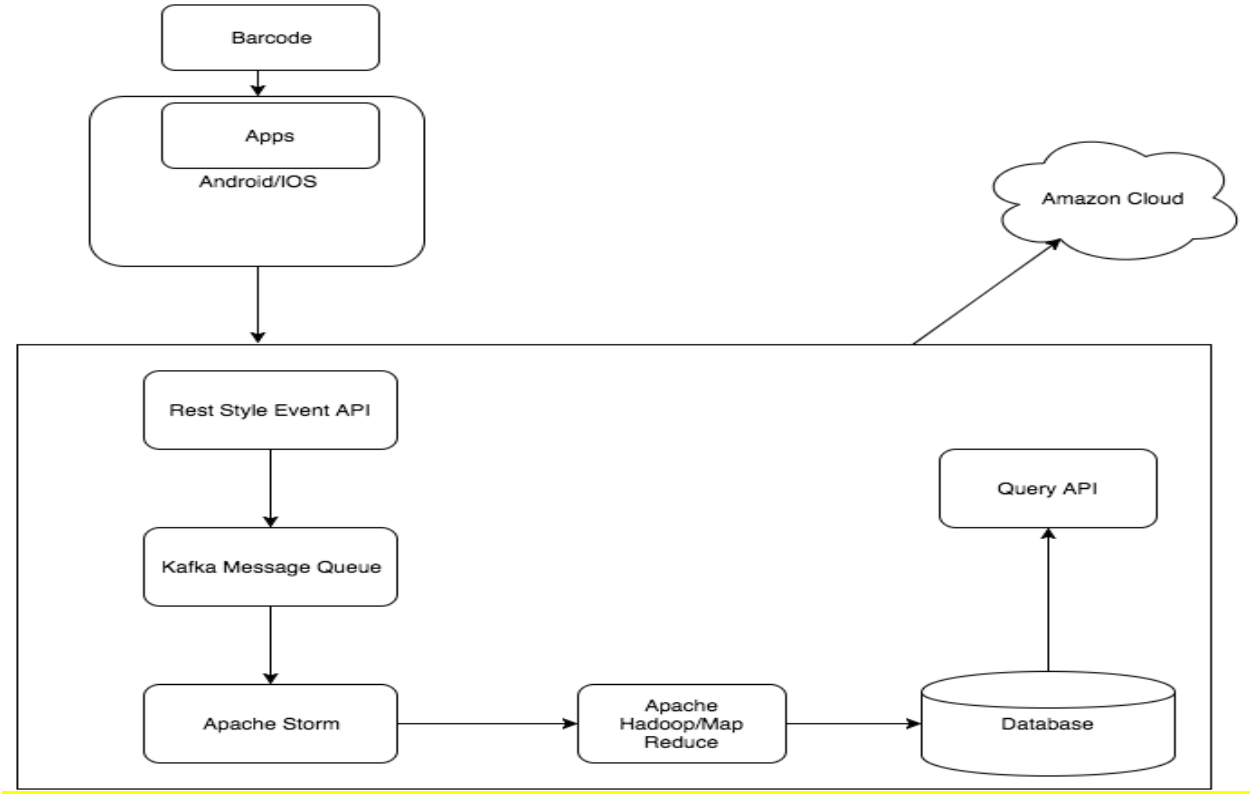

Figure 4: Relationships with the software architecture components

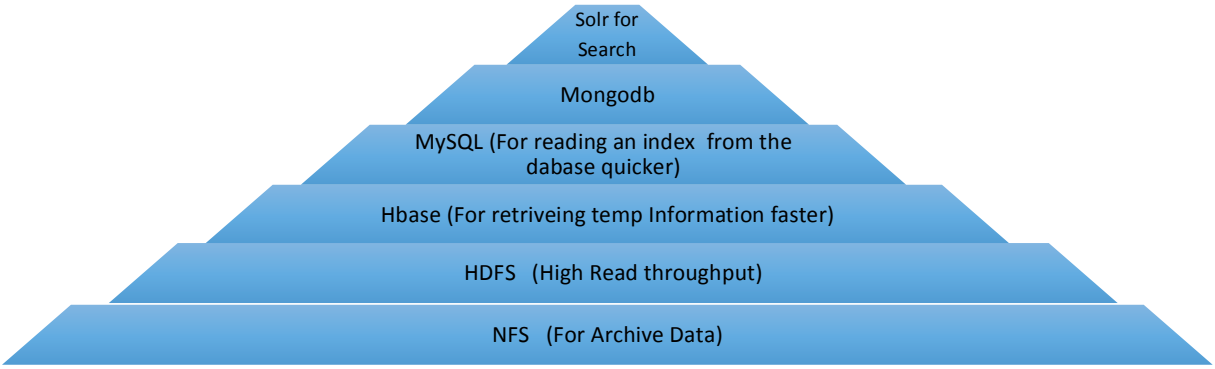

Figure 5: Technology stack for the software architecture

For getting purchasing trends of user and pushing the relevant coupons, information to end user, data analytics tools will be used.
These tools will extract the necessary data required for capturing the user centric needs and will help in providing better products list to user.
Sometimes due to poor Internet connectivity, user cannot access the product details from mobile application but using Google offline analytics customer can access the product list and add the items into cart without any hassles but for real-time transaction, Internet is required.

Amazon AWS will take care of all the hardware related requirements. Its load balancer utility will help in distributing the incoming traffic across multiple EC2 instances that will enable us to achieve fault tolerance and get seamless access to many users.
Most of the API's and Customer centric data would be saved on Amazon AWS that provides best in class security implementation for data reside on cloud.

For payment solutions, we are integrating kill-bill payment solution (open source platform) that provides a platform for building billing and payments infrastructures and offers all kinds of payment gateway in the world.

We use the following scenario to explain which parts of the software architecture comes into play in real life.

Persona-1: New Customer
Scenario-1
An individual walks in the store for the first time. The store aims to identify this individual as a new customer and make him/her as a regular customer. The possible actions to achieve this goal can be presented as:

- As soon as the individual steps in, the Wi-Fi asks him/her to join
- Joining the Wi-Fi requires to download and install the store app
- Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the individual's input.
- Upon registration the individual will get a promotion code
- The app will be adjusted based on the customer's' profile
- The individual's traversing of the store can be tracked via the Wi-Fi footprints
- Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances.
- Upon checkout, data will be send to storage

Table 11: Mapping of scenario-1 with software technology

Action	Software technology
As soon as the individual steps in, the Wi-Fi asks him/her to join	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS)
Joining the Wi-Fi requires to download and install the store app	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS)
Upon downloading the app, the individual is asked to register via one time password (OTP) authentication, along with personal profile. Personal profile can be created from the individual's social media profile or the individual's input.	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2) Data Analytics (Apache Storm, Apache Hadoop and MapReduce)
The app will be adjusted based on the customer's' profile	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2) Data Analytics (Apache Storm, Apache Hadoop and MapReduce)
The individual's traversing of the store can be tracked via the Wi-Fi footprints	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Cloud (Amazon AWS, S3, EC2) Data Analytics (Apache Storm, Apache Hadoop and MapReduce)
Upon checkout, the individual will get an offer of extra promotion, if he/she invites his/her acquaintances	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2) Data Analytics (Apache Storm, Apache Hadoop and MapReduce)
Upon checkout, data will be send to storage	Front End (Java, NodeJS, React, HTML5, CSS_

	OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2) Data Analytics (Apache Storm, Apache Hadoop and MapReduce)

Persona-2: Existing customer
Scenario-2
Existing customer, who likes beer, walks into the store. The store wants to present the most relevant products to the individual and where the products can be found. The assumption here is the person uses deals to buy the beers he/she wants. The possible actions to achieve this goal can be presented as:

- As soon as the individual steps in, the app makes an alert
- Upon opening of app, the customer gets notified on beer deals and the corresponding aisles, where the deals are located
- Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with relevant products and the aisles where they are located.
- The individual's traversing of the store can be tracked via the Wi-Fi footprints
- Customer buys products
- Track which of the relevant items customer bought and which items were ignored

Table 12: Mapping of scenario-2 to related software technology

Action	**Software technology**
As soon as the individual steps in, the app makes an alert	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2) Data Analytics (Apache Storm, Apache Hadoop and MapReduce)
Upon opening of app, the customer gets notified on beer deals and the corresponding aisles, where the deals are located	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2) Data Analytics (Apache Storm, Apache

	Hadoop and MapReduce)
Upon adding beer to cart, customer gets notified about relevant items such as lemons, ice, and ice cases. App alerts customer with relevant products and the aisles where they are located.	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2) Data Analytics (Apache Storm, Apache Hadoop and MapReduce)
The individual's traversing of the store can be tracked via the Wi-Fi footprints	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2)
Customer buys products	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2)
Track which of the relevant items customer bought and which items were ignored	Front End (Java, NodeJS, React, HTML5, CSS_ OS (Android, iOS) Database (Hbase, MySQL, Mongodb, Solr) Cloud (Amazon AWS, S3, EC2) Data Analytics (Apache Storm, Apache Hadoop and MapReduce)

Section G: Conclusion

In today's world, the importance of customer experience knows no bound for business expansion. In this work we propose a store-based software system that considers key issues such as scalability, security, and cost. In our proposal we have focused on customer personas and how such personas can be used to design architecture of software. In each of the sections, we describe how these personas map with the proposed architecture. A persona-based software design can help software teams to design and implement systems improving customer experience.

Along with considering customer personas our proposal relies on cloud-based services such as Google Cloud and Amazon Web Services (AWS). Such services have recently become extremely popular amongst companies, as they are moving towards an Infrastructure as Service (IaaS) based solutions. The above-mentioned services are available in different platforms, and provide software development kits (SDKs) in multiple languages. Software companies can benefit from such as solution as such solutions are more flexible, reliable, and cost effective in terms of management and maintenance. Use of cloud-based services also help in better management of computing resources, and focus on business instead of system being the headache. We hope this system will help companies to propose and implement system solutions for clients that want to improve customer experience.

Acknowledgements

We earnestly thank our mentor Phuc M Tran, and the program coordinator Kalpesh Sharma, for their help.