Super Kings

Farmacy Food System
Architecture Specification
11/30/2020

1. Introduction

1.1. Purpose and Intended Audience

The purpose of this document is to give the stakeholder a clear and precise description of the Farmacy Food system from the perspective of the software architecture component and connector (C&C) view. The intended audience of this document is all system stakeholders. It is a point of reference for all stakeholders to review and use at any time during the product development lifecycle.

1.2. Scope of Product

Farmacy Food system is a meal ordering system that provides customers with meals around their dietary needs and active lifestyles to support their overall well-being. The Farmacy Food system will provide the following services:
- Browse Meal Catalog
- Customize Meal Order
- Purchase Meal Order
- Manage Meal Preparation
- Manage Meal Purchase.

Figure 1 presents a level 1 use case diagram that provides an overview of the main functionalities provided by Farmacy Food system and the interactions between actors and the system. The actors, represented by stick figures, are external entities that interact with the system. The use case, represented by ovals, elucidates the actors' interactions with the system.
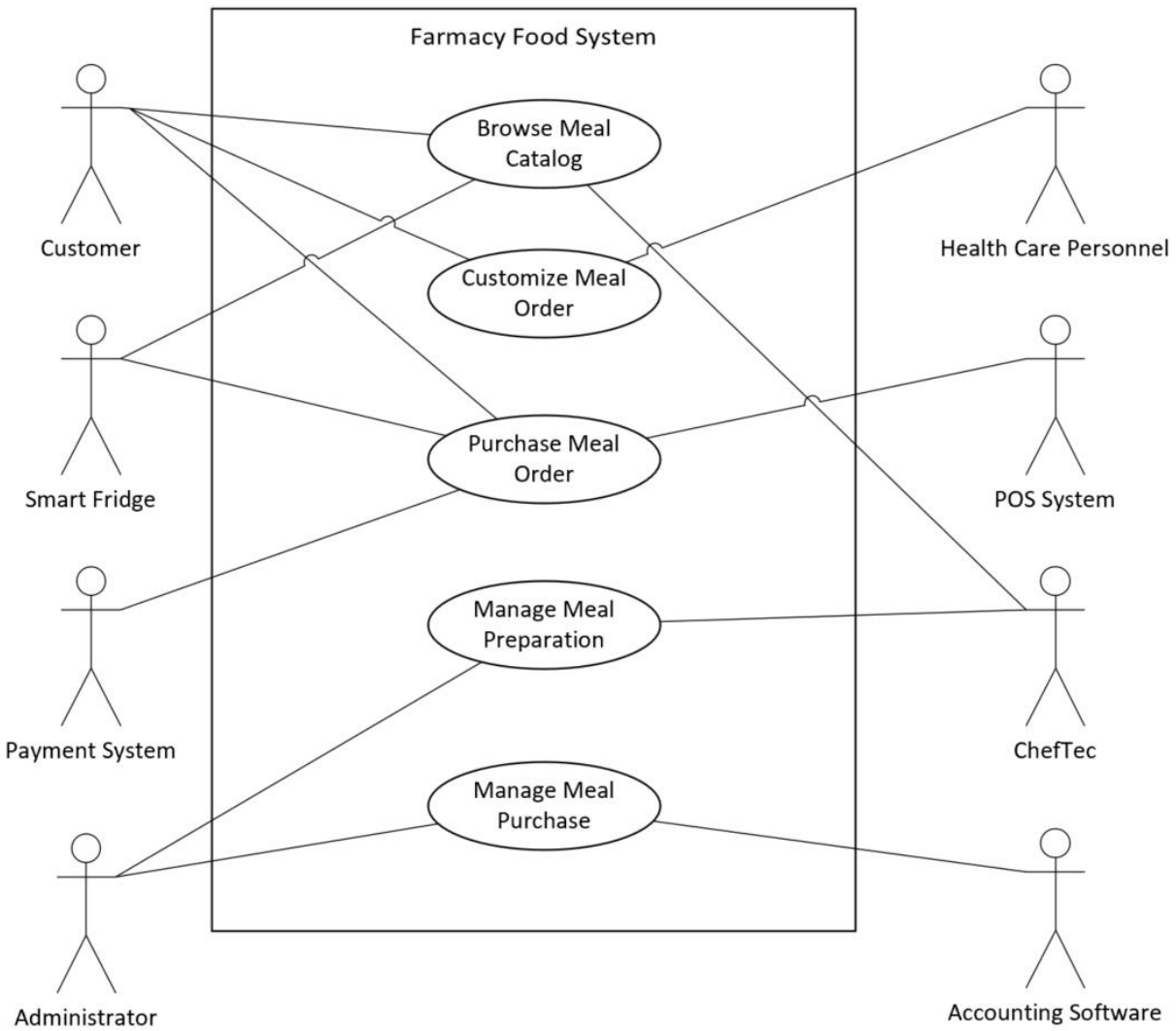
Figure 1: Level 1 Use Case Diagram

1.3. Requirements

Table 1 presents the requirements gathered from interview, research, and project description from the client.

Table 1: Requirements from Client, Interview, and Research

No.	Requirement
1	Users: dozens of automated fridges and representative run kiosks, thousands of customers.

2	Must integrate with 3rd party smart fridges to obtain inventory and purchase activity
3	Smart Fridges Produce item inventory levels and purchases. The smart fridges have a cloud based management system that handles communication with the Smart Fridge so obtaining this data would be through an API.
4	Must integrate with point of sale system at kiosks
5	The Kiosk is a sublet space inside another business where we will sell our product but have an employee handle the transactions through a point of sale. The same data should be accessible through the POS systems API's.
6	Mobile and Web accessible
7	Support providing feedback on items of verified purchases and in app surveys
8	Accept coupons and promotional pricing (local, regional, and national)
9	Send inventory updates to central kitchen (Cheftec)
10	Long term would like to allow multiple vendors to offer items through points of sale
11	Want to harvest data to provide personalized recommendations based on users health goals, purchase history, and item ratings
12	Provide personalized meal recommendation through profiles (individual-based, family-based, subscription-based, purchase history, item ratings)
13	Maintain nutrition profiles which include health conditions and dietary restrictions (HIPAA regulation)
14	Maintain preference profiles which include food preferences
15	Maintain location profiles which include pickup location preferences and delivery method preferences

16	Maintain purchase profiles which include meal selection and frequency in meal purchases
17	Monitor health impact based on meal choices, frequency in meal consumptions, and nutrition profile
18	Browse meal variety and availability of meals (as real time as possible) that meet customers' profiles (nutrition, preference, and location). Nutritious information about the meals should also be provided.
19	Purchase meals based on availability of meals at purchase location
20	Purchase meals based on customers' profiles
21	Make real time suggestion for meal choices based on customers' nutrition profiles (this requirement is only applicable to Smart Fridge purchase with a card, and the card is linked to a customer's profile)
22	Support purchase of meals via mobile app
23	Support purchase of meals via company's website
24	Support purchase of meals via POS
25	Support purchase of meals via SMS service
26	Support purchase of meals via Smart Fridge
27	Handle increased number of customer transactions to accommodate the increased number of smart fridges and kiosk locations.
28	Provide visibility of meal availability across the network (network refers to all the smart fridges and kiosk locations)
29	Predict meal stocking needs
30	Track purchases at each location
31	Track frequency of purchases for each meal
32	Track meal supplies (inventory)
33	Support smart fridges distribution strategy

34	Support kiosk at coffee shops distribution strategy
35	Support subscription service where more personalized meals will be provided distribution strategy
36	Support proxy meal pickup service
37	Support community funded meal services: Individuals/companies can donate money to support specific groups
38	Support notification service to customers (e.g. promotional offers, health information) via mobile app
39	Support notification service to customers (e.g. promotional offers, health information) via Company's website
40	Support notification service to (potential) customers (e.g. promotional offers, health information) via SMS service
41	Support the integration with Quickbooks (Accounting)
42	Support the integration with Cheftec (Inventory Control, Nutritional Analysis, Purchasing & Ordering)
43	Support rating of meal purchases
44	Support Support "could use your support" customer
45	Ability of adjusting meal prices based on meal expiration dates and on site purchase trends

1.4. Overview

This document contains four sections. The first section provides the purpose and intended audience of the document and the requirements of the Farmacy Food system. The second section presents architectural characteristics analysis. The third section presents the architectural design. The fourth section presents the architectural decision records.

2. Architectural Characteristics

Table 2 presents the architectural characteristics analysis based on the requirements documented in Section 1.3. The prioritized list of architectural characteristics for the Farmacy Food system is shown in Table 3. Based on the prioritized list of architectural characteristics, it was identified that event driven architecture style and microservice architecture style are suitable for the Farmacy Food system.

Table 2: Architectural Characteristics

No.	Requirement	Architectural Characteristics		
1	Users: dozens of automated fridges and representative run kiosks, thousands of customers.	Scalability - need to support customers purchasing meals concurrently via different purchase platforms	Elasticity - There might be a sudden burst when there is a promotion or after the holidays. With new year resolution, people might want to go back on a healthy diet after feasting on delicious food or during exam times at colleges, students don't have time to cook. Spike during meal times.		
2	Must integrate with 3rd party smart fridges to obtain inventory and purchase activity	Reliability - If smart fridges fail to communicate with the Farmacy Food system on item inventory levels and purchases, it will impact the reliability of the Farmacy Food system.	Availability: Farmacy food system plays the middle man role between cheftec and smart fridge.	Customizability	

3	Smart Fridges Produce item inventory levels and purchases. The smart fridges have a cloud based management system that handles communication with the Smart Fridge so obtaining this data would be through an API.	Reliability - If smart fridges fail to communicate with the Farmacy Food system on item inventory levels and purchases, it will impact the reliability of the Farmacy Food system.	Availability: Farmacy food system plays the middle man role between cheftec and smart fridge.	Customizability
4	Must integrate with point of sale system at kiosks	Reliability - If POS fails to communicate with the Farmacy Food system on item inventory levels and purchases, it will impact the reliability of the Farmacy Food system.	Availability: Farmacy food system plays the middle man role between cheftec and smart fridge.	Customizability
5	The Kiosk is a sublet space inside another business where we will sell our product but have an employee handle the transactions through a point of sale. The same data should be accessible through the POS systems API's.	Reliability - If POS fails to communicate with the Farmacy Food system on item inventory levels and purchases, it will impact the reliability of the Farmacy Food system.	Availability	Customizability

			Performance		
6	Mobile and Web accessible	Design: The client mentioned Farmacy Food system targets people who are between 18 to 65. For younger tech savvy people, they might prefer a native mobile application more than a web application. For the rest, a web application might be more suitable considering not everyone will have a smartphone. Having said that, we might need to specify specific performance or mobile-sensitive characteristics.	Performance		
7	Support providing feedback on items of verified purchases and in app surveys	No special architecture characteristics seem necessary to support this requirement.			
8	Accept coupons and promotional pricing (local, regional, and national)	Customizability - the coupons and promotional pricing might be based on locations and other criteria. This might lead to microkernel architecture.			
9	Send inventory updates to central kitchen (Cheftec)	Availability - If Cheftec cannot access Farmacy Food system to			

		retrieve information about meal inventory, the central kitchen will not know how many meals to produce.			
10	Long term would like to allow multiple vendors to offer items through points of sale	Scalability - need to support many POS	Customizability		
11	Wants to harvest data to provide personalized recommendations based on users health goals, purchase history, and item ratings	Compliance due to HIPPA regulations	Data Security - due to the handling of sensitive data.	Transparency - What does Farmacy Food do with the harvested data?	
12	Provide personalized meal recommendation through profiles (individual-based, family-based, subscription-based, purchase history, item ratings)	Customizability - meal recommendation might be individual-based, family-based, and subscription-based. This might lead to microkernel architecture.	Precision/accuracy/correctness regarding the recommendation based.	Robustness - What is the impact of operational mistakes that lead to incorrect personalized meal choices?	Transparency - How does the Farmacy Food system go about making the meal recommendation? Working with the Health insurance company, FDA.
13	Maintain nutrition profiles which include health conditions and dietary restrictions (HIPAA regulation)	Compliance due to HIPPA regulations	Data Security - due to the handling of sensitive data.	Transparency - What does Farmacy Food do with the nutrition profiles?	
14	Maintain preference profiles which include food	No special architecture characteristics seem necessary to			

	preferences	support this requirement.			
15	Maintain location profiles which include pickup location preferences and delivery method preferences	No special architecture characteristics seem necessary to support this requirement.			
16	Maintain purchase profiles which include meal selection and frequency in meal purchases	No special architecture characteristics seem necessary to support this requirement.			
17	Monitor health impact based on meal choices, frequency in meal consumptions, and nutrition profile	Compliance due to HIPPA regulations	Data Security - due to the handling of sensitive data.	Precision/accuracy/correctness regarding health impact	Transparency - What does Farmacy Food do with the health impact information?
18	Browse meal variety and availability of meals (as real time as possible) that meet customers' profiles (nutrition, preference, and location). Nutritious information about the meals should also be provided.	Availability - If Farmacy Food system fails to provide meal information, it might affect customers' meal choices or purchase.	Performance		
19	Purchase meals based on availability of meals at purchase location	Availability & Reliability - If POS and smart fridge fail to communicate with Farmacy Food system about the			

		availability of meals, customers might not get the real time information regarding meal availability.			
20	Purchase meals based on customers' profiles	No special architecture characteristics seem necessary to support this requirement.			
21	Make real time suggestion for meal choices based on customers' nutrition profiles (this requirement is only applicable to Smart Fridge purchase with a card, and the card is linked to a customer's profile)	Availability - If Farmacy Food system fails to provide meal information, it might affect customers' meal choices or purchase.	Performance		
22	Support purchase of meals via mobile app	Security - dealing with online payments			
23	Support purchase of meals via company's website	Security - dealing with online payments			
24	Support purchase of meals via POS	No special architecture characteristics seem necessary to support this requirement.			
25	Support purchase of meals via SMS	No special architecture			

	service	characteristics seem necessary to support this requirement.			
26	Support purchase of meals via Smart Fridge	No special architecture characteristics seem necessary to support this requirement.			
27	Handle increased number of customer transactions to accommodate the increased number of smart fridges and kiosk locations.	Scalability - need to support customers purchasing meals concurrently via different purchase platform	Elasticity		
28	Provide visibility of meal availability across the network (network refers to all the smart fridges and kiosk locations)	Reliability - If smart fridges/POS fail to communicate with the Farmacy Food system on item inventory levels and purchases, it will impact the reliability of the Farmacy Food system.	Availability		
29	Predict meal stocking needs	No special architecture characteristics seem necessary to support this requirement.			
30	Track purchases at each location	No special architecture characteristics seem necessary to support this requirement.			

31	Track frequency of purchases for each meal	No special architecture characteristics seem necessary to support this requirement.			
32	Track meal supplies (inventory)	No special architecture characteristics seem necessary to support this requirement.			
33	Support smart fridges distribution strategy	Scalability - need to support many smart fridges	Customizability		
34	Support kiosk at coffee shops distribution strategy	Scalability - need to support many POS	Customizability		
35	Support subscription service where more personalized meals will be provided distribution strategy	No special architecture characteristics seem necessary to support this requirement.			
36	Support proxy meal pickup service	No special architecture characteristics seem necessary to support this requirement.			
37	Support community funded meal services: Individuals/compa nies can donate money to support specific groups	Transparency - Farmacy Food system should provide transaction records on how the money is spent in supporting specific groups			

38	Support notification service to customers (e.g. promotional offers, health information) via mobile app	Customizability - Farmacy Food system needs to support notification service on different platforms.			
39	Support notification service to customers (e.g. promotional offers, health information) via Company's website	Customizability - Farmacy Food system needs to support notification service on different platforms.			
40	Support notification service to (potential) customers (e.g. promotional offers, health information) via SMS service	Customizability - Farmacy Food system needs to support notification service on different platforms.			
41	Support the integration with Quickbooks (Accounting)	Configurability/cust omizability			
42	Support the integration with Cheftec (Inventory Control, Nutritional Analysis, Purchasing & Ordering)	Configurability /Customizability			
43	Support rating of meal purchases	Performance			

44	Support Support "could use your support" customer	No special architecture characteristics seem necessary to support this requirement.			
45	Ability of adjusting meal prices based on meal expiration dates and on site purchase trends	No special architecture characteristics seem necessary to support this requirement.			

Table 3: Prioritized List of Architectural Characteristics for the Farmacy System

Priority(Most important to Least important)
Reliability
Availability
Compliance
Data Security
Scalability
Elasticity
Performance
Customizability
Transparency

3. Component and Connection View

This section contains all the information pertaining to the component and connection (C&C) view as it pertains to the Farmacy Food system.

3.1. Workflow and Actor/Action Approach Analysis

Workflow and actor/action approaches were used to identify the components of the Farmacy Food System. Figure 2 shows the result of the workflow and actor/action analysis.
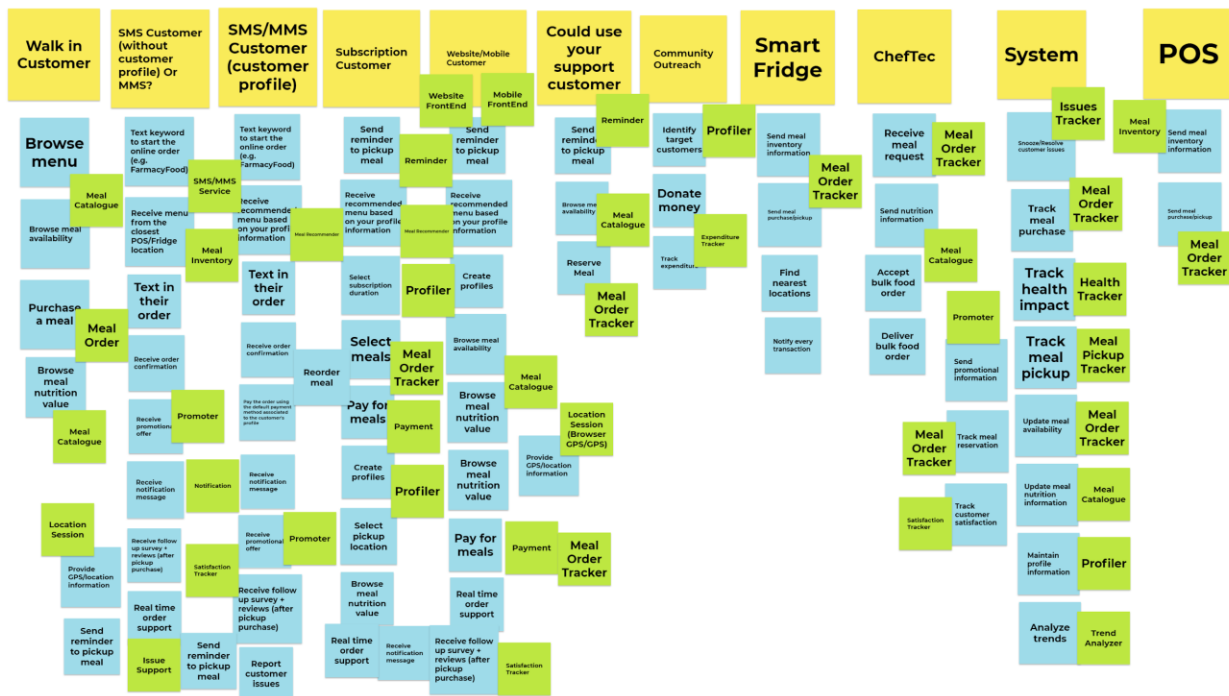

Figure 2: Workflow and Actor/Action Approach Analysis

3.2. C&C Overall View

Figure 3 presents the component and connection (C&C) view of the Farmacy Food system. Figure 4 presents the key for the view. Blue rounded rectangle represents an external system. Uncolored rounded rectangle represents a service. Uncolored rounded rectangle with database icon represents a service that owns its data. The database icon is used to represent a service owning its own data. Asynchronous communication between components is represented by dotted lines. Synchronous communication between components is represented by solid lines. Cylinder shape represents an event queue. The view can also be accessed via this lucid chart link: https://lucid.app/invitations/accept/539d7bf4-84ed-4549-b10c-c3ea7ede82a7. The first tab of the lucid chart presents the final submission. The second tab presents the round 1 submission.
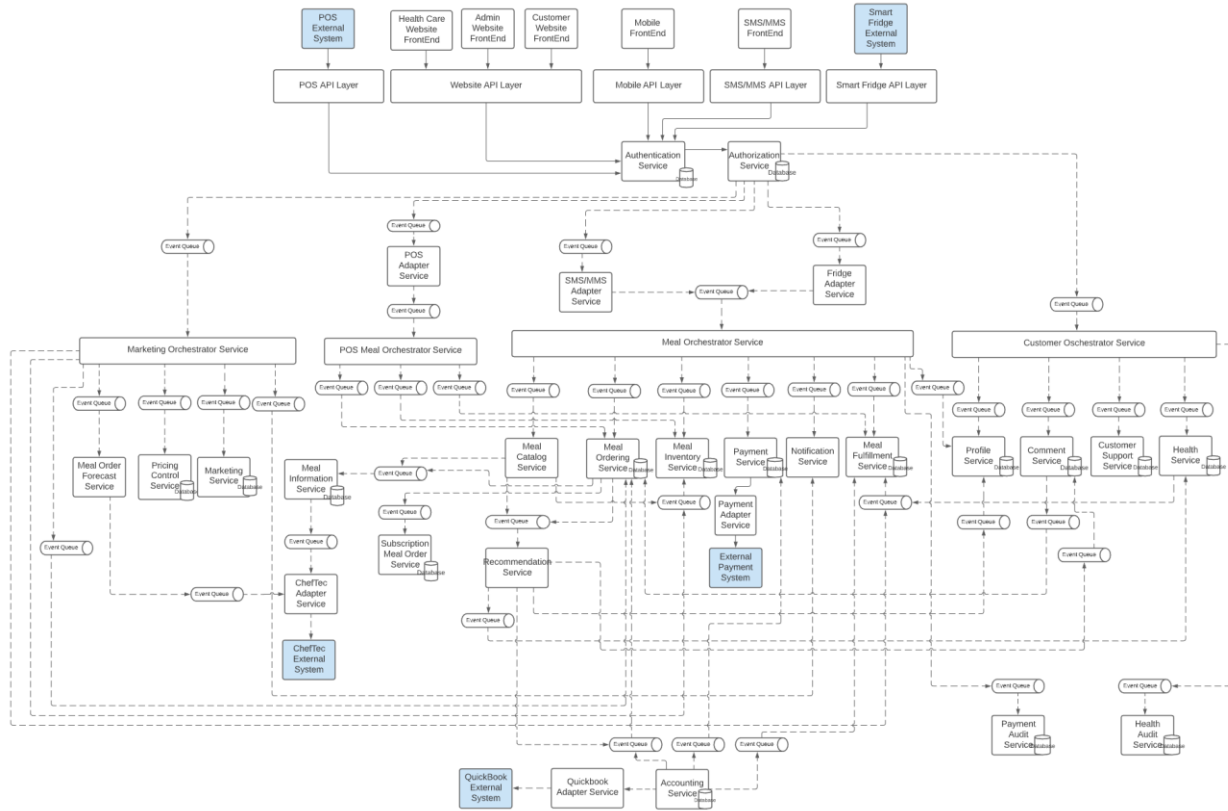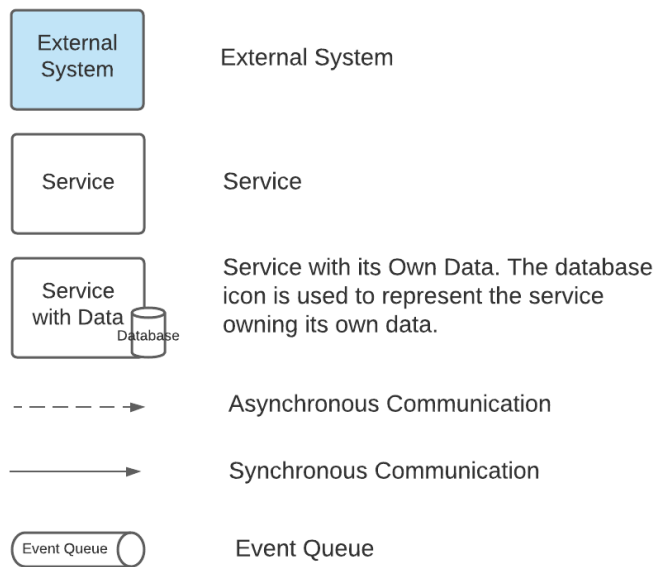
Figure 3: C&C View of Farmacy Food System

Figure 4: Key

3.3. Element Catalog

This section names each element in this view and lists the properties of each element. An element can be either a service or communication. Please see Table 4 for details.

Table 4: Elements and Their Properties

Element Name	Type	Description
Health Care Website FrontEnd	Service	This service is the user interface of the Farmacy Food website for healthcare personnel.
Admin Website FrontEnd	Service	This service is the user interface of the Farmacy Food website for administrators.
Customer Website FrontEnd	Service	This service is the user interface of the Farmacy Food website for customers.
Mobile FrontEnd	Service	This service is the mobile user interface of the Farmacy Food system.
POS API Layer Service	Service	This service exposes the end points of services available to the POS external system and performs data validation and data sanitization on inputs.
Mobile API Layer Service	Service	This service exposes the end points of services available to the Farmacy Food mobile application and performs data validation and data sanitization on inputs.
SMS/MMS API Layer Service	Service	This service exposes the end points of services available to the SMS/MMS system and performs data validation and data sanitization on inputs.
Smart Fridge API Layer Service	Service	This service exposes the end points of services available to the Smart Fridge system and performs data validation and data sanitization on inputs.
Website API Layer Service	Service	This service exposes the end points of services available to the Health Care website frontend, Admin website frontend, and customer website frontend. It also performs data validation and data sanitization on inputs.

Fridge Adapter Service	Service	This service transforms system calls and handles all communications between external Smart Fridge systems and the Farmacy Food system.
POS Adapter Service	Service	This service transforms system calls and handles all communications between the external POS system and the Farmacy Food system.
SMS/MMS Adapter Service	Service	This service transforms system calls and handles all communications between external SMS/MMS systems and the Farmacy Food system.
ChefTec Adapter Service	Service	This service transforms system calls and handles all communications between external meal preparation and inventory management systems and the Farmacy Food system. It also receives and relays meal forecast information from the meal order forecast service to external meal preparation and inventory management systems. The client uses ChefTec as the external meal preparation and inventory management system. This is the reason why the service is called ChefTec adapter service and each adapter is dedicated to a specific system. There are three versions of ChefTec: Basic, Plus, and Ultra. Each offers a different set of functionalities. This design is based on the assumption that the client is using the ChefTec Basic version which provides physical inventory information, calculates recipe cost, and provides onscreen nutritional analysis and allergen information.
Meal Information Service	Service	This component handles nutritional value and allergen information of all meals. This service owns its own data.
Meal Order Forecast Service	Service	This service calculates the amount of meals that needs to be prepared for every

		meal restock cycle. The calculation is based on the meal inventory information from the meal inventory aggregator service and meal order history service.
Meal Order Service	Service	This service handles the ordering of meals, tracking of meal selection for each order, and the frequency of meal purchase.
Marketing Service	Service	This service handles all the promotion offers, e.g. discount in meals, free meals provided by sponsored organizations. This service owns its data.
Pricing Control Service	Service	This service controls the pricing of meals. It provides the ability to adjust meal prices based on meal expiration dates and on site purchase trends.
Meal Order Forecast Service	Service	This service determines the number of meals that need to be prepared.
Meal Orchestrator Service	Service	This service knows the steps involved in processing events related to the meal ordering and generates corresponding processing events that are sent to dedicated event channels to the corresponding meal ordering related services. It also handles concurrent events and error situations.
Meal Catalog Service	Service	This service handles browsing of meal selections and the availability of meals at locations.
Meal Ordering Service	Service	This service handles the creation of orders. It also maintains customers' meal selection and frequency in meal purchases. This service owns its data.
Meal Inventory Service	Service	This service aggregates all the inventory information from POS and Smart Fridges. [Req] This service owns its data.
Payment Service	Service	This service handles all payment

		processings and transactions. Payments are handled with different adapters depending on customers' payment method. This service owns its data.
Notification Service	Service	This service handles notifications to customers. Notifications can be related to customers' orders status and marketing information.
Meal Fulfillment Service	Service	This service monitors the pickup of the reserved and/or ordered meals. This service owns its data.
Recommendation Service	Service	This service generates meal selection recommendations based on food preference, health data, purchase history, and item ratings.
Health Service	Service	This service analyzes health risks based on health conditions and dietary restrictions and monitors health impact based on meal choices and frequency in meal consumptions. It also maintains health conditions and dietary restrictions information. This service has its own data.
Payment Adapter Service	Service	This service transforms system calls and handles all communications between external payment systems and the Farmacy Food system.
Subscription Meal Order Service	Service	This service handles all the subscription based meal ordering. This service has its own data.
Profile Service	Service	This service handles customer profile processing including creating new customer profiles, modifying customer profile information, and deleting customer profiles. It maintains customer information, customers' payment information, customers' food preferences, pickup location preferences and delivery method preferences.

		This service has its own data.
Comment Service	Service	This service handles rating of meal purchases. This service has its own data.
Customer Support Service	Service	This service handles all customer complaints regarding meal purchases. This service has its own data.
Pricing Control Service	Service	This service provides the ability to adjust meal prices based on meal expiration dates and on site purchase trends and controls pricing of meals.
Meal Order Forecast Service	Service	This service predicts the number of meals needed based on current inventory, meal orders, and fulfilled meals.
Authentication Service	Service	This service verifies the identity of users. This service has its own data.
Authorization Service	Service	This service establishes the rights and privileges of a user. This service has its own data.
Marketing Orchestrator Service	Service	This service knows the steps involved in processing events related to the meal forecast, pricing control, and marketing and generates corresponding processing events that are sent to dedicated event channels to the corresponding meal ordering related services. It also handles concurrent events and error situations.
POS Orchestrator Service	Service	This service knows the steps involved in processing events related to the meal purchase from POS and generates corresponding processing events that are sent to dedicated event channels to the corresponding meal ordering related services. It also handles concurrent events and error situations.
Customer Orchestrator Service	Service	This service knows the steps involved in processing events related to the profiles,

		rating, customer support, and health and generates corresponding processing events that are sent to dedicated event channels to the corresponding meal ordering related services. It also handles concurrent events and error situations.
Payment Audit Service	Service	This service persists the states of payment as a sequence of state-changing events. It also can reconstruct the current state of payment by replaying the events.

This service has its own data. |
| Health Audit Service | Service | This service persists the states of health as a sequence of state-changing events. It also can reconstruct the current state of health by replaying the events.

This service has its own data. |
| Accounting Service | Service | This service aggregates all the financial transaction data.

This service has its own data. |
| Quickbook Adapter Service | Service | This service transforms system calls and handles all communications between the external accounting system and the Farmacy Food system.

The client uses Quickbook as the external accounting system. This is the reason why the service is called Quickbook adapter service and each adapter is dedicated to a specific system.

This service does not own data. |

4. Architectural Decision Record

This section presents the architectural decision records that document architecture decisions. Each architectural decision record has five sections: Title, Status, Context, Decision, and Consequence.

4.1. Use of Event Driven Microservice Architecture

Title
Use of Event Driven Microservice Architecture

Status (Proposed, Accepted, Superseded):
Proposed

Context
Farmacy Food system needs to support customers purchasing customized meals concurrently via different purchase platforms. It needs to handle a sudden burst of customers purchasing meals when there is a promotion or after the holidays. With new year resolution, people might want to go back on a healthy diet after feasting on delicious food or during exam times at colleges, students don't have time to cook. There might also be spikes in customers during meal times (breakfast, lunch, and/or dinner). It also needs to be reliable and available so that failure in one feature will not take down the entire system.

Decision
We will use event driven microservice architecture for the Farmacy Food system.

The use of Microservice Architecture gives us the scalability, reliability, elasticity, and availability required by the Farmacy Food system. However, it introduces performance and transactional issues. Event driven architecture was used to address that. Services publish events while other services consume events. There is no direct coupling between services. Asynchronous communication between services via event queues. Transactional issues are reduced by using orchestrators and sagas.

Consequences
The cost of using microservice architecture is higher compared to other architectures for a startup with limited resources. However, the need to address scalability, reliability, elasticity, availability, and constant changes in technologies justify the use of event driven microservice architecture.

4.2. Use of Adapters

Title:
Use of Adapters

Status (Proposed, Accepted, Superseded):
Proposed

Context: Customers can order prepared meals through the Farmacy Food system via SMS, website, mobile application, at POS locations, and at Smart Fridges.

Decision
Adapter services transform system calls and handle all communications between the external system (e.g. SMS/MMS software, Toast software, and Smart Fridge software) and the Farmacy Food system so that customers can place meal orders through the Farmacy Food system via SMS, website, mobile application, at POS locations, and at Smart Fridges. Having an adapter for each external system addresses the customizability architectural characteristics.

Consequences
Having a single adapter for each system can increase the testing time and effort.

4.3. Use of Orchestrators and Sagas

Title:
Use of Orchestrators and Sagas

Status (Proposed, Accepted, Superseded):
Proposed

Context:
Some features in the Farmacy Food system need to be executed in a particular order and maintain transactional records. The system also needs to handle error situations.

Decision
We will use multiple orchestrator and saga services with each service associated with a particular domain or group of events to reduce single point of failure and to increase throughput and performance.

Orchestrator and saga service knows the steps involved in processing events related to a workflow and generates corresponding processing events that are sent to dedicated event channels to the corresponding related services. It handles concurrent events, error situations, restarting capabilities. It also maintains data consistency across multiple services without using distributed transactions. This service addresses reliability and transparency.

Consequences
The tradeoff is coupling between services.

4.4. Use of Event Sourcing

Title:
Use of Event Sourcing

Status (Proposed, Accepted, Superseded):
Proposed

Context:
For the Farmacy Food system to be able to collect health related information, it needs to be HIPAA compliant.

Decision
We will use event sourcing to address the HIPAA logging requirement, transparency, and data security.

The Health service is responsible for storing all health related information and performing health related analysis. The data at rest are encrypted at the database level. Access is controlled by authorization service. Communications between the health service and other services are encrypted. Health service should be located in a private container/virtual machine that has a firewall.

The Health Audit service will store the states of health as a sequence of state-changing events. It also can reconstruct the current state of health by replaying the events. The service provides a reliable audit log to satisfy the HIPAA logging requirement.

Consequences
The tradeoff is performance when dealing with many events.

4.5. Notification Service

Status:
Proposed

Content:
The Farmacy Food system generates notifications to customers via mobile application, email, and SMS services. Notifications include promotional offers, health information, and reminders to pick up orders. This can be done via 3 services (Application notification service, email notification service, and SMS notification service) or one service (notification service).

Decision
We will use one service to handle the responsibility of generating and sending different types of notifications.

We made an assumption that the throughput for notification service using SMS, email, and via application notification would be similar. If the performance metrics for the three services would be significantly different, then we would split the notification service into three services, namely SMS notification service, email notification service, and application notification service.

Consequences
The service will need to have three protocol adapters, one for each communication protocol.