Version 3

High-Level Design

October 14, 2022

Issued by:

Algorithmic Alchemist

Team Lead

Sierra Harris

Team Members

Bryant Lam

Abhay Solanki

Faisal Al Muharrami

David Chan

Tania Adame

Github: https://github.com/abhay772/AA_Senior_Project/

Version History

Version #	Date	Reason for Change
Version 1	10/5/2022	Original Document
Version 2	10/12/2022	Updated design and added more details.
Version 3	11/23/2022	Updated the design to follow microservices. Updated behavior of error handling. Added: Entry Point Layer, and Decoupling some Microservices.

Table of Contents

Glossary (definitions/abbreviations)

- Property Manager: A property owner, commercial property manager, and landlord, anyone that manages the property.
- Service Provider: An organization or company that provides a service.
- PMTOGO : Algorithmic Alchemist proposed single-page web application for Property Maintenance and Renovation.
- DAL: Data Access Layer
- DAO: Data Access Object
- DB: Database
- DBL: Data base Layer
- EP: Entry Point
- SL: Service Layer
- PL: Presentation Layer
- TLS: Transport Layer Security

Overview

The high-level design document will describe the general system and architecture of PMtoGo. This document will address the system as a whole and present a visual estimate of the system's architecture. In addition, this includes how the system handles logging, errors, and input validation at a high-level.

We are going to use a layered architecture. A layered architecture is an architectural pattern that is composed of several isolated layers, each layer only has access to the layer next to them, which makes it easier for testing and reusability in the future at the cost of reducing performance. The layers are separated into 6 layers: presentation, entry point, manager, service, data access, and data store.

- Presentation Layer:
    - This layer will be responsible for building user requests with input into HTTP/HTTPS requests with JSON payloads, and receiving responses from the server.
    - This layer will also handle the Single Page View displayed on the client browser, and update the view according to the response for the requests.
    - This layer will also do input validation for user inputs when constructing requests.
- Entry Point:
    - This layer will be translating HTTP/HTTPS requests into class object(s) received from the Presentation Layer, to be used by the Manager Layer.
    - It also translates the results or responses from the Manager Layer into HTTP/HTTPS responses to send it to the presentation later.
- Manager Layer:
    - Manager Layer will be responsible for receiving requests and data from the Entry Point layer, and calling the appropriate service to process the request and data.
    - Manager Layer will also be responsible for receiving response from the service layer, and transport it to the entry point layer.

    - Service domain models will reside in this layer meaning the manager can create service objects and use their functionalities.
    - It will call the corresponding service in the Service Layer and receive the response and deliver it back to the Entry Point.

- Service Layer:
    - Service layer will be responsible for handling all the business logic for the domain model.
    - This layer handles all data manipulation, accessing, and storing by calling the Data Access Object(DAO) from the DAL..
    - The Application Model and Reusable code will reside in this layer, and will be used to handle all the “Cross-cutting concerns” for the domain model.
    - This layer will be responsible for all the processing, analysis and calculations for the request and data from Manager Layer.
    - And also will be responsible for transporting the result back to the Manager Layer.
- Data Access Layer:
    - This layer will be responsible for addition, modification and deletion of data from databases.
    - This layer will also be responsible for transporting data from the datastore to the Service layer.
    - This layer will also be responsible for handling modification requests from the service layer.
- Database Layer:
    - This layer will be used to store, modify, and access data using relational databases.

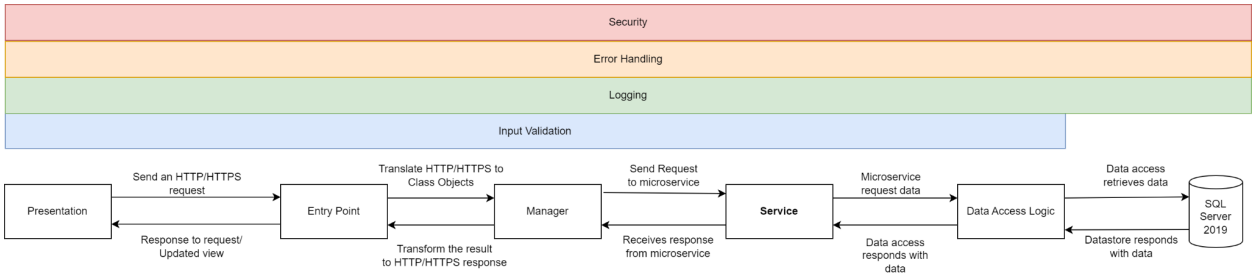
Architecture

This project will follow a Layered Microservice Design Pattern. The reason we choose this type of layered architecture is due to every layer being isolated which makes it easier for testing and reusability in the future at the cost of reducing performance.

This Project will use MVVM or Model - View - ViewModel for the front end. This structure allows for the separation of the Model and View. Where if the Model is changed the View does not need to be updated, and vice versa. The ViewModel separates the View from the Model so that the view is not dependent on any specific model form. This makes the MVVM model easily maintainable and scalable. And MVVM is also a good tool while testing services and functionalities during development.

Over every layer, we have security and error handling to keep data secure and input validation over the presentation, manager, services, and data access layer. We chose to handle errors in every layer because an error can happen at any and all layers. By doing so we are able to tend to errors on each layer and notify users of any errors. We also chose to secure each layer of the architecture to ensure the proper authorization and authentication of the users and system is appropriate to their layer. This ensures no user can access data they do not have authorization for and that the system is secure from outside attacks. We decided to only validate input on the first four layers because the only input to the data store will be by the DAL.

High-Level Diagram



Microservices

- User Microservice
    - This microservice will be handling User Profile and Calendar because the User Profile is reliant on the calendar to show appointments stored.
- Property Microservice

    - Property evaluation and dashboard will be combined in a single microservice because the dashboard will need to use property evaluation to give an up-to-date estimate of the value of the property.
- Improvement Microservice
    - Maintenance and renovation is combined with the DIY manager because the implementation of a smart saver will be used in the DIY manager for marking the prices of materials.
- Account Microservice
    - The user management functionality is not dependent on other features except User Microservice so it will not be combined with other features.
- Service Microservice
    - Service management is the property manager users setting up services and the request management is the other side which is the companies who will interact with the service request. Since both features need to interact with each other they will be grouped together.
- Document Microservice
    - The document storage with optical text search functionality is not dependent on other features except for User Microservice so it will not be combined with other features.
- Crime Alert Microservice
    - The crime alert functionality is not dependent on other features except User Microservice so it will not be combined with other features.

Domain Models:

The Domain model for PMTOGO includes Property Manager, Service Provider, Services, Property, Service Appointment, Property Evaluation, Project, Crime Alerts, and DIY video sharing.

Application Models:

The application model for PMTOGO includes Calendar, Document Storage, Dashboard, cost estimate, ratings, video sharing,

Why Microservices architecture?

We chose to go for a layered architecture because it would work best as the architecture for PMTOGO and here are the advantages:

- Horizontal scaling is a lot easier if a single server becomes overloaded it can just open another server containing the same microservice.
- As the services are independent, increasing the scope is easier as a service can be easily added/updated.
- Website stays online even after a failure of a service because of loose coupling.
- Scope of each microservice is defined making the codebase easier to understand.
- Isolated microservices make testing a lot easier.
- Security can be implemented at every layer.

We acknowledge the drawbacks of said architectures in terms of

- Communication between services is more complex.
- Adding a service requires adding data stores and logging.
- If the microservice servers are far away from each other then it can increase the delay from traveling server to server
- It will require more hardware and be more complex to implement
- If one layer doesn't work the whole system will have difficulties.

Security:

- A User will need to enter their Email and the Password associated with that account. Which on a successful attempt will send an OTP to the user. With the correct OTP the user will be logged in. Check this
- This web app will accept both HTTP and HTTPS requests, with JSON payloads.
- This web app will use role based authorization. The role will either be Property Manager, Service Provider or Admin.
- Admin registration cannot be completed without a Company ID(student ID), and must not be accessible to the public.
- User is given a maximum storage amount of 128MB, and PDFs,
- User is given a maximum storage amount of 128MB, and 720p or lower,

- Users are restricted to one appointment per day.
- User is restricted to 150 characters per Crime Alert Description,
- User is restricted to 100 characters per Property Description field,
- Passwords and all sensitive details will be stored in an encrypted database.

Input Validation:

- Input validation will be done at all the layers, except Database.
- This makes the layers reusable in future projects. As the input validation is done locally on every layer, the layer will not be dependent on adjacent layers for input validation.
- This does make processing slower with repeated data validation checks at each layer.
- We chose not to handle input validation in the database because only the data access layer will have access to it.
- The Data Access Layer will be designed to work with a relational database and will handle the input validation for the Database.
- Therefore, if a different kind of database is used in the future, the data access layer will have to be updated to do the input validation for that kind of database.
- A whitelist will be applied for input validation, which checks for,
    - Correct format,
    - input data type,
    - data consistency,
    - Constraints, i.e. required by the business rule
    - and input range allowed.

Error Handling:

- As all the layers are prone to errors, we will be implementing error handling in each layer.
- Although it involves repetition of code and reduced performance, this ensures a better understanding when troubleshooting.

- Each layer will deal with its respective categories of error to ensure that the layers are independent and reusable.
- The Presentation layer will handle user input related errors by displaying the exception message to the user and prevent their input from passing through.
- The Entry point layer will handle invalid entry points by preventing connection and providing clear exception messages so connections can be fixed accordingly.
- The Manager layer will handle errors between objects' interactions and their state by terminating their current function and catching the exception.
- The Data Access Layer will handle SQL connection errors, data type errors, and primary key errors before SQL queries by preventing connection and queries to the database.
- The Database Layer will cover primary key errors, data collision, and other errors that occur within the database by preventing modifications of existing data and insertions of conflicting new data.

Logging:

- Logging will be performed in each layer, to make debugging faster.
- In the presentation layer, we will be logging any errors and invalid inputs.
- In the manager layer, we will be logging any errors and invalid inputs.
- In the service layer, we will be logging any errors and invalid input along with how much each microservice is used and so if there is any bottleneck we can expand and open a new server assisting in that microservice. In addition to successful and unsuccessful login attempts
- In the data access layer we will be logging any errors, invalid inputs, and status of requests.

References

"Application-Manager-Driver Architecture." *F´*, https://nasa.github.io/fprime/v1.5/UsersGuide/best/app-man-drv.html#:~:text=The%20manager%20layer%20manages%20a,at%20all%20by%20the%20Application

Baeldung. "Layered Architecture." *Baeldung on Computer Science*, Baeldung, 11 Nov. 2021, www.baeldung.com/cs/layered-architecture#:~:text=What%20Is%20a%20Layered%20Architecture%3F&text=In%20these%20frameworks%2C%20components%20that,part%20of%20the%20overall%20system

"C5: Validate All Inputs¶." *C5: Validate All Inputs - OWASP Proactive Controls Documentation*, https://owasp-top-10-proactive-controls-2018.readthedocs.io/en/latest/c5-validate-all-inputs.html.

Dang, Anh T. "MVC VS MVP VS MVVM." *Medium*, Level Up Coding, 14 Oct. 2020, https://levelup.gitconnected.com/mvc-vs-mvp-vs-mvvm-35e0d4b933b4

"Data Validation." *Wikipedia*, Wikimedia Foundation, 22 July 2022, https://en.wikipedia.org/wiki/Data_validation#Data-type_check

"Exception Handling." *Wikipedia*, Wikimedia Foundation, 17 July 2022, https://en.wikipedia.org/wiki/Exception_handling#Exception_handling_based_on_design_by_contract

GeeksforGeeks. (2022, June 9). MVVM (Model View ViewModel) Architecture Pattern in Android. Retrieved October 14, 2022, from https://www.geeksforgeeks.org/mvvm-model-view-viewmodel-architecture-pattern-in-android/

"Input Validation." *Input Validation - an Overview | ScienceDirect Topics*, https://www.sciencedirect.com/topics/computer-science/input-validation

Lteif, Georges. “High-Level Solution Design Documents: What Is It and When Do You Need One.” *Operational Excellence in Software Development*, 8 Sept. 2022, https://softwaredominos.com/home/software-design-development-articles/high-level-solution-design-documents-what-is-it-and-when-do-you-need-one/

MildWolfieMildWolfie 64511 gold badge55 silver badges1111 bronze badges, et al. “How to Clearly State to the User What Characters Are Valid.” *User Experience Stack Exchange*, 1 Aug. 1961, https://ux.stackexchange.com/questions/57491/how-to-clearly-state-to-the-user-what-characters-are-valid.

“MVVM – Advantages.” *Tutorials Point*, https://www.tutorialspoint.com/mvvm/mvvm_advantages.htm

Publications, Manning. “The Layers of a Cloud Data Platform.” *Manning*, 9 Oct. 2020, https://freecontent.manning.com/the-layers-of-a-cloud-data-platform/

Published By - Kelsey Taylor. “What Are Microservices and Their Advantages and Disadvantages?” *HitechNectar*, 5 Oct. 2022, https://www.hitechnectar.com/blogs/5-pros-and-cons-of-microservices-explained/

Richards, Mark. “Software Architecture Patterns.” *O'Reilly Online Learning*, O'Reilly Media, Inc., https://www.oreilly.com/library/view/software-architecture-patterns/9781491971437/ch01.html

“Service Layer.” P Of EAA: Service Layer, https://martinfowler.com/eaaCatalog/serviceLayer.html

Smith, Jon, et al. “Using Entity Framework with an Existing Database: User Interface.” *Simple Talk*, 17 May 2021, https://www.red-gate.com/simple-talk/development/dotnet-development/using-entity-framework-with-an-existing-database-user-interface/

Website security guide: Secure & protect your website. Sucuri. (2022, July 27). Retrieved October 5, 2022, from https://sucuri.net/guides/website-security/

Vatanik Vong, Lecture on MV* structures, CECS 491A Sec 04, CSULB, November 28, 2022.