

COMP 40070 Design Patterns

Term paper

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1 Introduction

This paper mainly covers two things:

- A. How I applied software patterns from an existing online booking and delivery system that supplies gas cylinders for domestic use to a personal project named “Thuli” in 2014, which was aimed at delivering water to the general public of India.
- B. Instances where the observed software patterns from 2014 still get used.

Around 2014, there was a huge technology gap on online services^[1] for tax, electricity, water, etc, provided to the public by the Indian government. This means that all of these services were accessible only by phone and paid in-person, making lives difficult for all of the families, individuals and government officials involved in this process to carry out each of these individual services. The only online service and delivery system that was figured out by then, was booking and supply of Liquefied Petroleum Gas (LPG)^[2] cylinders for domestic usage between registered distributors and the residents.

2 Patterns in LPG delivery system

2.1 City gas distribution network

The first reusable software pattern from the digitised LPG delivery system is determining which distributor to assign for delivering gas cylinders, when an order is placed. A distributor closest to the clients address with stock availability was allocated for delivery. At that time, the total number of LPG cylinder distributors was 13,900^[4]. With the increase in population, the number of distributors would also increase, making this a tedious task for the staff if they had to manually check with each of the distributors. Prior to moving digital, this network existed on paper & through back and forth telecommunication between distributors within this network. For example, say when the cylinder stock was unavailable in a distributor branch, they would call up other distributors belonging to the same company and within their range to cover up for their delivery .

“In 2006, the Petroleum and Natural Gas Regulatory Board (PNGRB) of India granted authorisation to gas cylinder distributors to form a City Gas Distribution (CGD) network within a resident area of a country.” ^[3]

This issue was handled by forming small networks under each residential area, an order for that area will be handled by that corresponding network of distributors only, thereby micro-sizing the task. This network was then leveraged by moving this whole system online and hence, when there was a change in state of cylinder stock in any of the nodes (distributor) in this network, it was published to the central order taking system, AKA *observer pattern*.

But the question here is how does the online order taking system determine which CGD network to tap into and check for distributors & stock availability? This is done by determining what resident area zone the requester belongs to or has placed the order in. Each resident area has its own CGD network.

2.1.1 Strategy to determine resident area zone

A resident area zone is determined by its urban land cover.

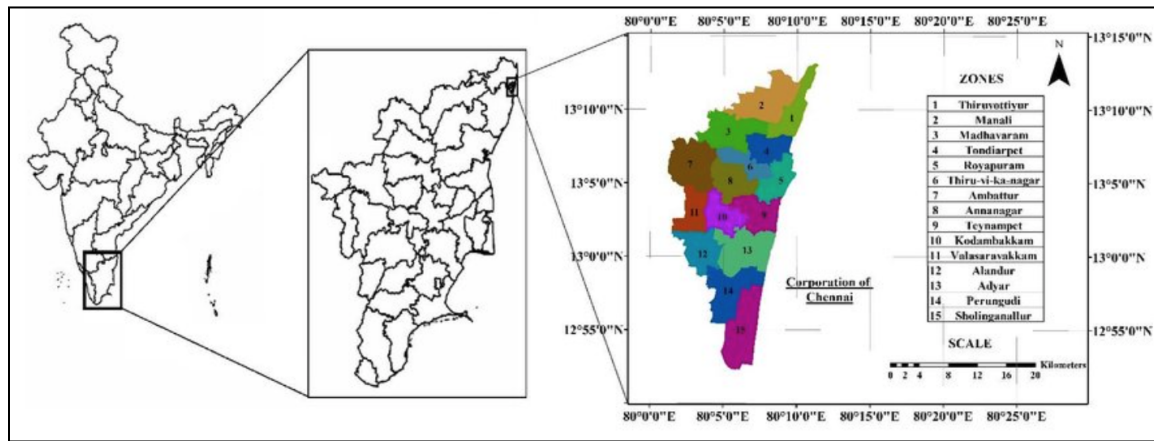


Figure 1. Map showing the location of Tamil Nadu (state in India) (left), predefined resident area zones and its boundary coordinates of Chennai (a city in Tamil Nadu) from its urban land cover (right)^[5]

The order system determines the corresponding zone in which the resident order address is in and then proceeds with the process of finding the gas distribution network information of that zone alone, saving a lot of computation space and time, technically. A similar working pattern can be observed in cellular communications too. A mobile connects with the base station(s) only belonging to its corresponding cellular node or zone.

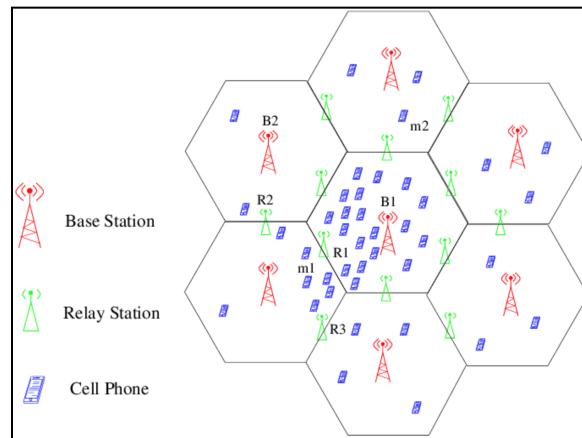


Figure 2. A cellular network^[14]

2.2 The booking process - A template pattern

When a resident places an order, the following steps are followed:

1. The resident address gets converted into a coordinate.
2. Each distributor has its own location coordinate and the distributor which is nearest to the resident is determined.
3. The corresponding stock availability of that distributor is checked in the system.
4. If stock is available, then proceed to step 5. Otherwise, repeat step 2 to find the next nearest distributor to the resident in the CGD network.
 - a. If all distributors within the CGD network are checked, then end the booking process and notify the user of stock unavailability.
5. Enquire on mode of payment.
 - a. If payment is cash on delivery, then proceed to step 6.
 - b. Otherwise, use third party services (for example, Paytm, Gpay ,etc) to initiate the user payment process and check for payment approval.
 - i. If payment is not approved, end the booking process and notify the user of unsuccessful payment. Otherwise, proceed to step 6.
6. Place the order with the respective distributor and notify the central order taking system on the cylinder stock state change.
7. Notify the user on successful order.

Hence, such an exhaustive, but well defined process like the above can be used to find any type of distributor connected through a network within a zone.

2.3 Delivery object state change - A state pattern

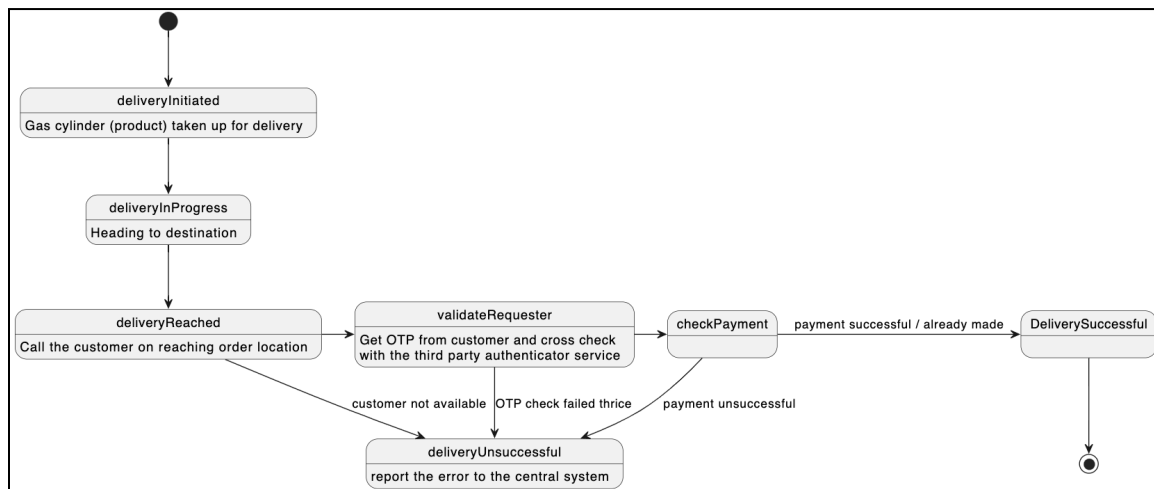


Figure 3. Depiction of delivery object state change

It can be observed that the above depicted process for customer validation and payment checks on delivery is currently commonly used in many door delivery services. For example, Amazon online order deliveries.

2.4 Client registration and login - A template pattern

The fourth reusable software pattern is the template followed to successfully register and login LPG gas distributors and residents to the online service provider application.

Registration:

1. An authorised gas distributor will have an unique distributor id and an Indian resident will have a unique 12 digit social security number, AKA Aadhar id ^[6].
2. A separate third party service is used to validate the information (Aadhar id, resident proof) entered into the system according to their choice of whom to register as.
3. The client is then provided with a login id and one time password that can be modified when they login the first time.

Login:

1. The unique id of distributor or a 17 digit LPG ID will act as the user id. The correctness of this user id and corresponding password is checked by an authenticator service.
2. On successful authentication, it returns a session cookie with an expiry, which is then attached to the header of all of the proceeding application level API calls.

Hence, it can be observed that such a generic registration and login template can be reused for any of the online public services provided by the government as it would require the users to go through the same process with a similar requirement on user information, at least with respect to details required from a resident.



Figure 4. A screenshot of the login portal from MyLPG.in government website which is used to avail LPG order and delivery services^[8]

2.5 Stock identification - SKU Numbers

As observed from Figure4, there are only 3 types of domestic gas distributors - Indane (introduced in 1965), Bharatgas (introduced in 2010^[11]) and HP gas. The requester chooses one of these gas agencies and it might or might not be available for that resident zone. On top of this, a gas cylinder may be available in different quantities. For example, Indane gas provides four different types of cylinders ranging from small to big – 5 litres, 14.2 litres, 19 litres and 47.5 litres^[9].

In a day, a delivery agent will have close to 100+ deliveries. So how are each of these products identified when preparing for delivery and identified on customer delivery? According to Indian express (a very reputed journal and news cooperation), over 6 million gas cylinders are delivered everyday^[13]. Therefore, tagging each item or bunch of items with its order id would be laborious and time consuming. Additionally, it would also be difficult to keep track of all of the products sold/delivered from the inventory. Hence, the products are grouped in a certain way, stored and identified making it easy to identify and track their quantity.

Original GST Tax Invoice for LPG Cylinder

Indane **AVERY GAS SERVICE**

R - 104/4, Ramesh Park, Laxmi Nagar, Delhi-110092
Ph : 011-22442983, 22466949, 7065039752 GSTIN : 07ABKPC3117B1ZD

Emergency Service Cell
Dial 9911554411
Only for Leakage
Dial 1906 (24x7 Days)

Order Type : Refill Order (DBC)
Cons No/ID : 17614/7500000039942987
Name : MOHAMMAD FIROZ
Address : Z-II-166, WELCOME J.J. COLONY
SEELAM PUR, DELHI
PHOTO CHOWK, EAST DELHI
DELHI-110053
Landmark :
Category/Area : Domestic/ Seelam Pur
Equipment/Qty : 14.2 Kg / HSN:27111900 / 1

Quota : 142 Kg of Quota 170.4 Kg
Advance/Loan (Rs.) : 435.00
Subsidy Amt will be transferred to Bank A/c linked to
Aadhar XXXXXXXX6579
Now Book & Pay online-Use IndianOil One app or ex.indianoil.in

Tax Invoice : S-100855387830
Tax Invoice Date : 17-11-2020
Booking No : 2-000802561573
Booking Date : 17-11-2020
Price (Rs.) : 565.71
UTGST@2.5% (Rs.) : 14.14
CGST@2.5% (Rs.) : 14.14
Online paid (Rs.) : 0.00
Cashless Incentive (Rs.) : 0.00
Net Payable (Rs.) : 594.00

दुपट्टेन बुकिंग नम्बर बदल गया है, अब 7718955555 पर कॉल कर गैस बुक करें।

You can book your LPG cylinders using WhatsApp from Registered Mobile No Type Refill And Unregistered Mobile No Type REFILL#CONSUMER ID WhatsApp it to 97588880024
Consumer Service Cell : 1800-233-3555 (Toll Free). For 24 Hours Booking Dial 9911554411 Online Booking Visit: www.ex.indianoil.in

Figure 5. Image of LPG order invoice^[12]

In the above figure, the highlighted portion of the order invoice shows how an equipment/product is identified, say, HSN:27111900. This is called a SKU number. SKU stands for “stock keeping unit” and is used to uniquely identify products, track inventory levels within a company and predict sales of that product.

- First part of the SKU (for example, HSN), represents the department, product or the supplier.
- Next few characters represent the features of the product (for example, size).
- The last 3 characters represent the number of products available in the warehouse and the sequence in which they are being accessed. For example, 001 would represent the 1st cylinder and 900 would represent the 900th cylinder. The central order taking system also keeps track of item list per supplier in a zone and its stock using this unique 12 character SKU number per supplier.

A similar working pattern from SKU generation to usage can be observed in many of the retail companies. It's using these SKU numbers that products are identified and stocked up in retail shops like Woodies Ireland. In fact, these SKU numbers can be seen in the label of products that we purchase everyday (Figure 6).

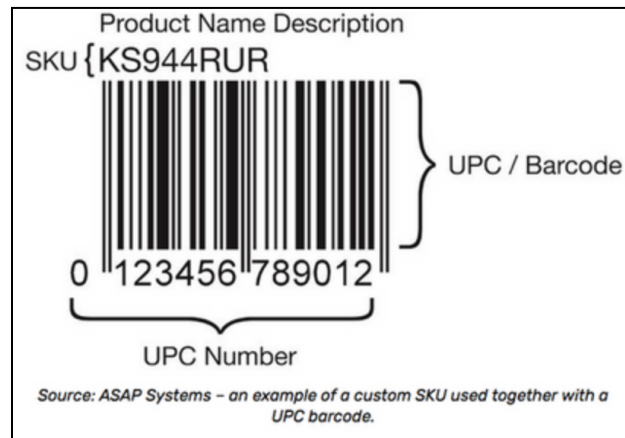


Figure 6. Image of Product barcode and SKU breakage^[7]

In fact SKU architecture may be one of the most vastly used software patterns in the world. Everything we use daily is a product from an inventory and all of these are shipped, sold, traded and tracked successfully because of SKUs.

3 Online LPG service system as an MVC pattern

From the above sections, it is clear that the whole system is a bunch of patterns working together cooperatively. The mechanism behind each of these software patterns is independent of one another and hence can be used outside of the context of LPG service (which is evident from the examples given above). These patterns come together at the service level, according to the actions performed by the service user. Hence, looking at this service as an MVC pattern will broaden its area of application.

Model:

It consists of the following information:

- Resident area zone list and its boundary coordinates.
- Zone wise supplier network and their locations.
- Corresponding stock data like product information, stock availability of each distributor.
- State of delivery objects.

View:

Client interacts with the service using the view. It has the following properties:

- It implements a strategy pattern to delegate user actions to the controller.
- It is also a composite pattern in a way that is just a collection of front end components like text inputs, buttons, etc. When implemented on top of libraries that render components from JSON input, the view can also be made customisable. Crayons UI

toolkit is an example library which constructs UI components from JSON when supplied in a certain format.

Controller:

It is the backbone of the whole system and performs the following activities:

- Subscribes to each supplier information in the model to get notified of change.
- It also figures out what action is delegated to it and in response to the same might or might not change the state of the model.
- Sends information to view in case it needs to be changed.

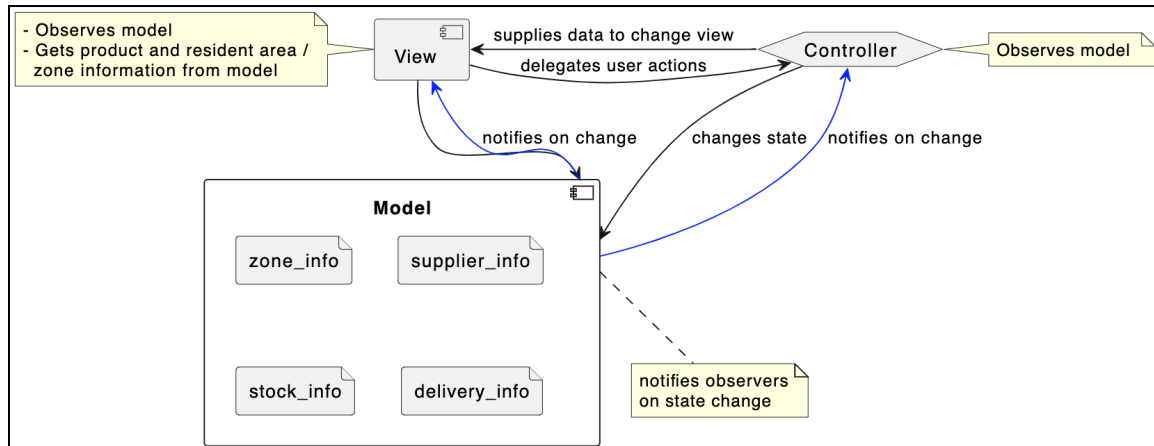


Figure 7. Depiction of LPG service as an MVC pattern

It can be observed that the controller and view are the stable components in this system. The controller performs action delegated to it and responds accordingly. The view is dependent on the input it receives. The only unstable component that keeps changing is the model. A change in model information not only affects the user experience of the system but also changes what type of service the system provides, in hindsight. For example, if distributor and product information of LPG gas is replaced with that of water, the same system can be used to service water delivery. This is how the project “Thuli” (which means ‘a drop of water’ in Tamil) was born.

4 Project Thuli

The vision of project “Thuli” was to replicate the existing digital booking and gas delivery service for water distribution across Tamil Nadu, a state in India. Therefore, the following changes were made to achieve this:

Model level changes:

- Replace information of gas distributors and its network with that of water suppliers.
- Replace product types - Indane, HP and Bharat gas, with types - Domestic, partially commercial.
 - The product in demand can be 6K, 9K or 16K litres, similar to how gas cylinders are available in different quantities

Controller level changes:

- Implement an adapter (AKA. Adapter pattern) to work with the new model structures and perform actions on top of it.

Apart from these two changes, everything else remains the same and is reused.

5 Existing systems which use these software patterns

5.1 Food delivery and taxi services

Two of the obvious systems in which the patterns from section 2 are used are food delivery and taxi services. In both these services, the pickup agent is assigned with respect to the resident zone location.

- In case of food delivery, the agent is assigned with orders belonging to their zone.
- In case of taxi service, the client is shown the availability of pickup agents in that zone within a range of 10 kilometres (this value changes with different applications).

The guidelines for post order object state change and the required checks for this change are also duped. Cross checking OTP (One Time Password) to validate the requester and verifying payment information are the two main actions performed by these services.

Examples of such services where these patterns can be observed are Zomato, OLA, etc.,

5.2 Identification of COVID-19 hotspots

The pattern to form a network with nearest distributor enclosed by a zone was enhanced to form a network of active covid cases in a zone and identify danger zones. Addition of a new node to the network was introduced via factory pattern. A decorator was written on top of this factory pattern to count the number of new cases on a daily basis and to calculate the rate at which the confirmed cases were getting added to the network. The hotspots were categorised as the following:

- Red zone: more than 15 cases or double the increase in cases in comparison to the previous day^[11].
- Orange zone: less than 15 cases^[11].
- Green zone: No new cases in the past month^[11].

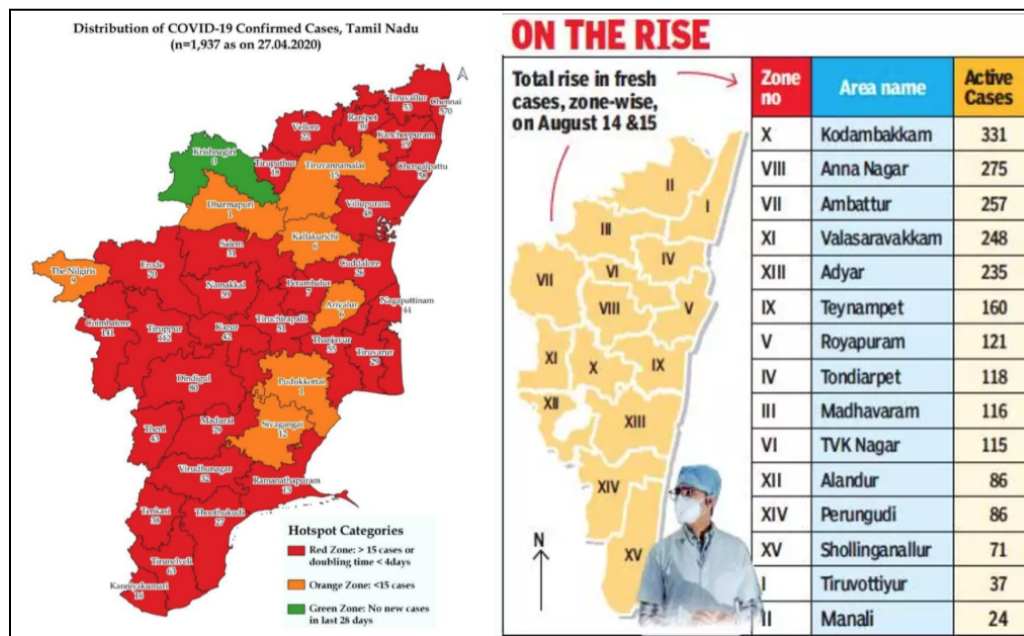


Figure 8. Distribution of covid cases and corresponding hotspots in Tamil Nadu, India (left) ^[11], Zone wise illustration of fresh COVID-19 case count (right) ^[15]

6 Conclusion

In this paper, all of the software patterns identified in online LPG order and delivery system were discussed in detail. Exemplification of these patterns in a totally different context were also elucidated. In addition to this, viewing the above system as an MVC pattern broadened it to be modified to build a water distribution system, project “Thuli”.

This project was also a proof that implementing such public services as an MVC pattern and having an adaptor instrumented at the controller level will provision the conversion of such similar government provided services into a digital format, most importantly with minimal changes.

Finally, some of the current widely used systems using the already identified software patterns were logically explored and comprehended.

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