Standardized Architecture for Conversational Agents a.k.a. ChatBots

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Abstract *— The emergence of new technologies, such as Siri, Alexa, Cortana and Google Now which are powered by natural language processing and speech recognition programs, are driving users away from mobile-first to voice-first interactions. Also, due to the rise of so many platforms including Facebook Messenger, WeChat, Skype, LINE, Viber, Telegram, Slack, Google Home and Amazon Echo, it is evident, that this disruptive technology of ChatBots will soon become omnipresent and we cannot avoid it. So the sooner we standardize the architecture and frameworks used to implement the ChatBot solutions, the better it would be for the benefit of all. This paper describes and proposes, a generic standardized architecture for design and implementation of custom ChatBot solutions.*

Keywords *— ChatBot, Conversational agent, AI (Artificial Intelligence), NLP (Natural Language Processing), ML (Machine Learning), IVR.*

I. Introduction

We all have the experience of talking to customer service on the phone (IVR - Interactive Voice Response). Most of the times, it's frustrating to use, as we have to pass through multiple menu options before we are actually connected to a human agent. Still we see all service providers have deployed this system as an interface for their customer service, even though it is not accomplishing its basic goal of reducing and shortening customer service calls. To add on to the frustration, the customer executives are available only for a few hours a day and few days a week. So instead of getting limited information at the end, it is always better if we are directed to the right place/agent to handle our request and provide all the information, in addition to suggestions for further actions. And this is where ChatBot solutions are playing a major role!

Basically, more and more people are spending more and more time in messaging apps, making the messaging apps as a platform of the future.

In light of all these technological developments, it becomes all the more important that we have a generic, standardized architecture and framework for ChatBots, also known as the conversational agents.

II. Need For a Standard Architecture

By definition, an architecture is a foundational structure, or set of structures, which can be used for developing a broad range of applications. It should describe as a method for designing a target state in terms of a set of building blocks, and for showing how the building blocks fit together. It should contain a set of tools and provide a common vocabulary. In simple terms, it enables the understanding, implementation, maintenance, and further development of a system.

As understood in the previous section, the rapid pace at which the ChatBot related technologies is gaining popularity, organizations are forced to reconsider the channel enablement strategies and for sure the related architectural approach. It is no longer sufficient to simply have a chat client on their web sites, or have a bot on Facebook. As consumers' expectations from applications are continuing to grow, it is most essential to have a scalable, sustainable and standardized architecture.

III. Typical ChatBot Solution Architecture

At the highest level, the proposed architecture for conversational agent look inherently similar to any other layered technology platforms or technology stacks. But of course, it has specificity to our domain of discussion.

Fig. 1. Portrays how an architectural view of a typical ChatBot solution and its processing ecosystem should look like. This architecture diagram clearly shows that the user interacts with the presentation layer, which encapsulates the various user interface components to communicate with the system. The presentation layer then communicates with the underlying business layer components to access functional capabilities of the system. The data layer manages access to local data, which is in turn is provided to the layers above through the service layer. Service layer is responsible for integrating with external/third party services for sharing the data for further usage or for gathering information required for adding value to the list of services. The utility layer provides common services such as configuration, security and other utility services.

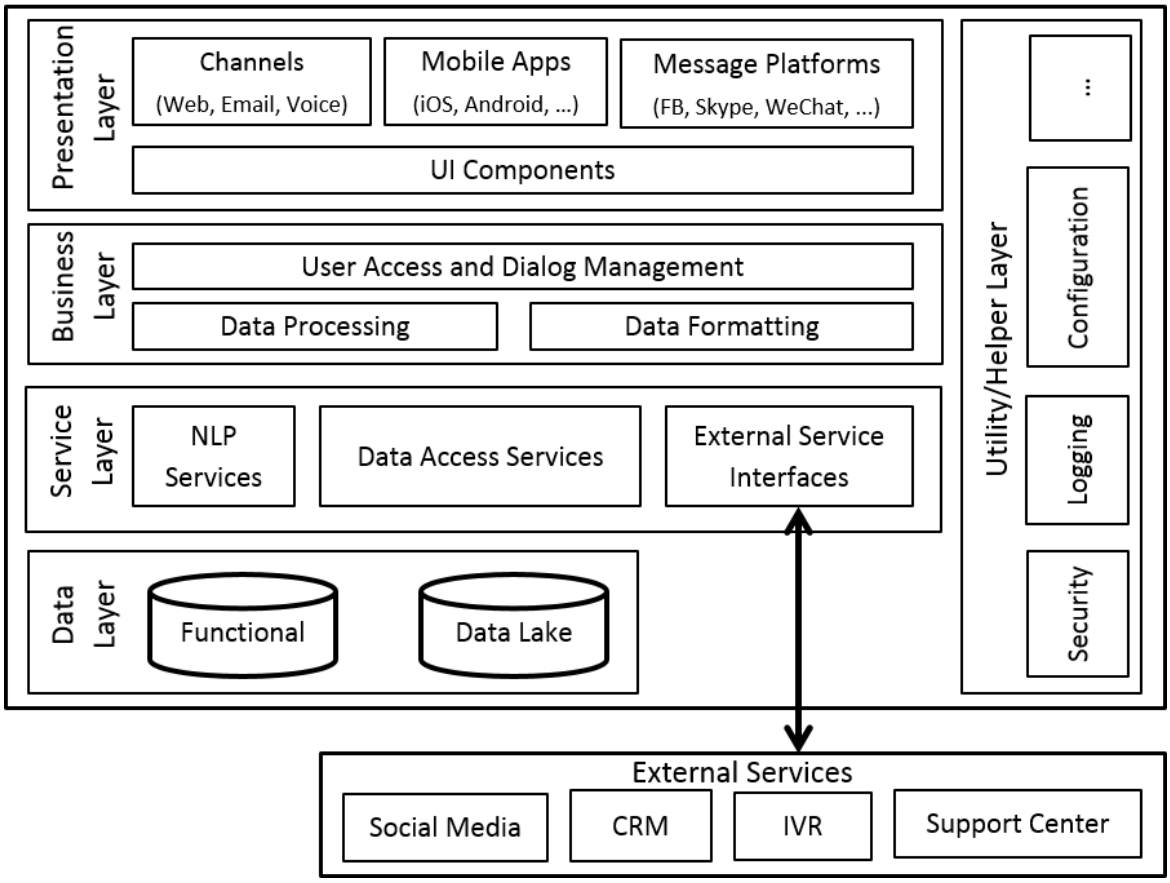

Fig 1: Typical ChatBot Solution Architecture

A. Presentation Layer

The presentation layer contains the components that implement and display the user interface and manage user interaction.

1) ***Multi-Channel Support*****:** If our customer response solution is available through only one channel, our business will be able to handle only few of our customers. For e.g. If we have a chat client on our website, then our agents would be able to cater customers via web chats only. Today's consumers doesn't want to be bound to any one particular channel, whether it is mobile, online, voice or social media. And if the customer support solutions are not enabled on all the rest of the firm's operational channels, then it would result in a poor user experience and may also become a disincentive to consumers that need a conversation on other channels. On the other hand, if we implement ChatBot solution and enable it across all the channels, we can stop worrying about the count of incoming enquiries and also about the time and duration of support to be provided. The only challenge in that case would be, to develop components to integrate and handle queries from all the different channels, whether it is Email, SMS, Text Messaging, Voice or from an IoT device.

2) ***Multi-Platform Support*****:** In the case of mobile application development, normally, there is lot of time and effort put on deciding which platform to support - iOS or Android? Unlike that case, "If you build it, they will come" is the best strategy with bots and conversational interfaces. But for sure, as it is explained earlier, the usage of messaging platforms is widespread, depending on geography, age and messaging capabilities. That means figuring out what and where to deliver, depending on our target customers and their needs, is the key to the solution. Whether it is Facebook Messenger, LINE, WhatsApp, Telegram, WeChat, Skype or Kik, each messaging platform have their own approach to serve its users, have their own unique and different interfaces and capabilities. In addition, the key point to note, is that each of these platforms are evolving, which means, this requires continuous monitoring and maintenance.

3) ***UI Components:*** Because we have multiple channels and multiple platforms to support, it is evident to implement common user interaction patterns as separate user components, which allows reuse in multiple user interfaces.

All these are the main reasons, our architecture proposes to have a standardized interface at the presentation layer, to enable easy communication

with all the current platforms and interfaces but also with the new platforms and their interfaces. This approach will ensure that we consider all the relevant factors as we develop our solution.

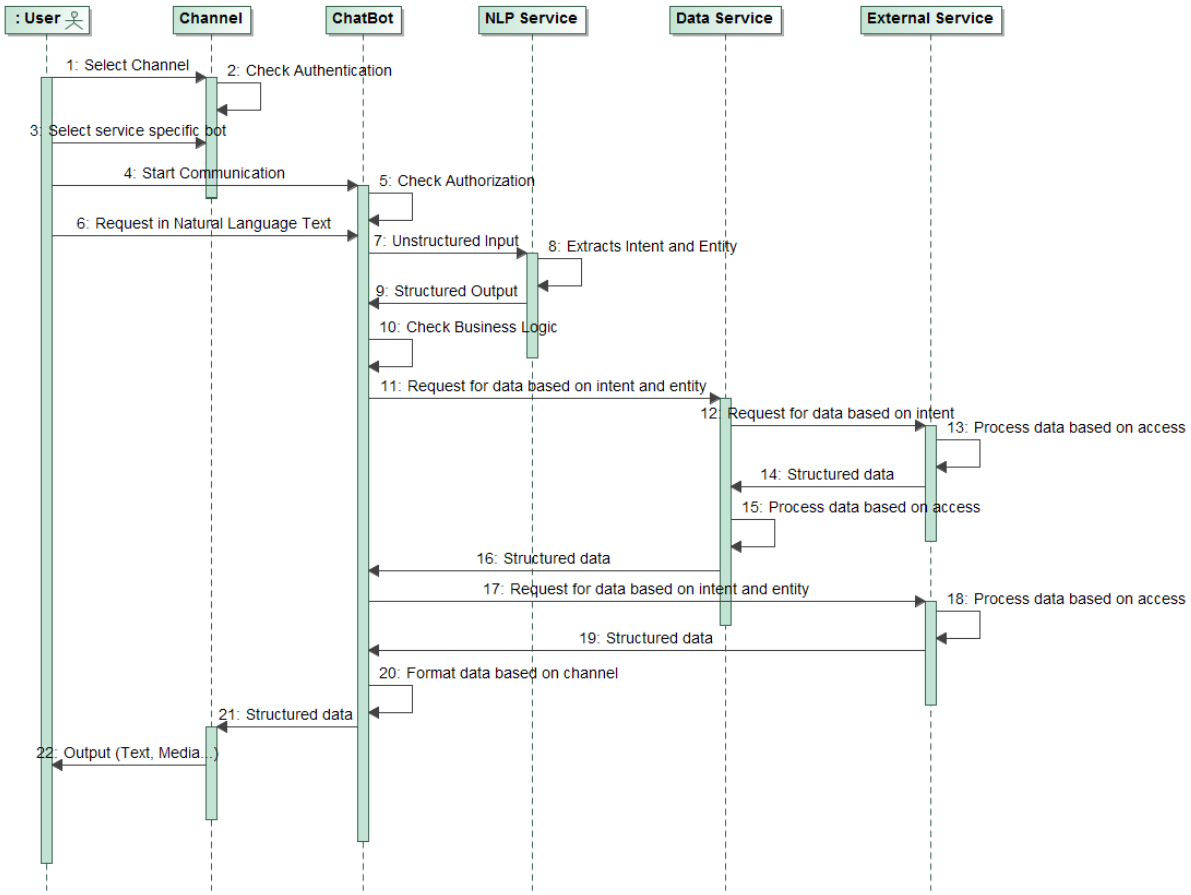

Fig 2: Typical ChatBot User Interaction/Flow

B. Business Layer

The following section describes the roles and responsibilities of the business layer components.

1) ***Data Processing:*** Business processes normally involve multiple steps that must be performed in the correct order. The data from the service layer also has to be transformed into real-world business entities, such as products and orders, and not as database entities, such as tables and views. In most cases, we have a multitude of services and their respective interfaces with their own entities and protocols for communication. The data processing components, many times, gather information from more than one service, to create one business entity. It is evident to identify common entity usage patterns and implement them as separate components, which allows us to reuse them in multiple use cases.

2) ***Data Formatting*****:** It is clearly understood by now, that an ideal ChatBot solution should be extendable enough to be able integrate with any existing platforms and channels and scalable enough to work with any new ones too. This means the implementation of such a solution needs to have connectors or plugins, which are able convert the processed data into the required format, which are in line with the UI requirements and capabilities. For e.g. Facebook, LINE and WeChat kind of interfaces allow display of Image and text together and display controls, but Amazon Echo and Google Home uses only voice. So the same processed data has to be formatted according to the user interaction/interface.

3) ***Dialog Management*****:** The most important and unique component of a ChatBot solution architecture is dialog management. The whole experience of a ChatBot relies on this component's performance. As the name suggests, it is responsible for managing the dialog with the user. For a seamless experience for the user, this component might be required to at least manage, if not maintain, the context of conversation and user's profile and preferences. The NLU (Natural Language Understanding) part is taken care of, with the help of a specific AI/NLP service.

Depending on the context, domain and features being provided by the ChatBot solution, all the data from the service layer components needs processing

to form a meaningful set of data structure as per the requirements. But as we have to support multiple platforms and multiple channels, we should have an application façade which will enable us to listen and respond according to the respective touchpoints by using different communication technologies.

C. Service Layer

Service layer components provides access to both internal and external data, business functionality, middleware connectivity and other services.

1) ***NLP Services:*** The most basic functionality of any NLP service component is NLU. The success and failure of a ChatBot solution depends on the choice of NLP service, whether it is internally developed or provided by an external vendor. Though support of number of languages can be an important criteria, but if the NLP service is not able to understand the native slangs and does not learn and improve automatically or programmable, then the number of languages supported does not matter. The most important feature of an NLP service, is how efficient is its machine learning capability based on how many and which state-of-the-art Artificial Intelligence algorithms.

2) ***Data Access Services:*** The standard interfaces provided on top of the locally available data or remote data comprises, the data service components. When messages are being passed between a service and a consumer, most of the times, the message needs to be transformed into a format that the consumer can understand. As the ChatBot solution would need to integrate with different set of services, we need to implement adapters to provide access to these services which converts the data from services into a format that the other components also understands.

3) ***External Service Interfaces:*** Depending on the functionalities provided by the ChatBot solution, we might need to integrate with different set of external services. This again raises the need to implement adapters to provide access to these services which converts the data from services into a format that the other components also understands. One of the important external service, which should be integrated with is the connection with the customer agent console, which may the existing channel of communication with the consumers (IVR). Once again we would need to develop reusable adaptors to communicate with the different systems available the many vendors.

The service layer components can be deployed on the same tier as other layers, or on a separate tier depending on the performance and isolation requirements of the implementation. However, it is always recommended to have the service layer components also to reside on the same physical tier as the business layer components in order to maximize the performance of the system.

D. Data Layer (Storage)

It is very critical to have an efficient and secure data access and that is why it is of utmost importance to have a well-defined approach in designing the data layer. In addition, in order to reduce the development time and improve the maintenance of the data layer, an effective design approach is quintessential.

In case of a ChatBot solution, it becomes all the more important to have a proper design of the data layer, simply for the fact that, not only there is lot of data collection and storage but also faster data access is important. There are lot of services and components which rely on this data storage and access at all times. For. E.g. storage of all communication with the users, analysis of the data collected, performing machine learning techniques on the data. This essentially means that storage systems also comes under purview of Big Data processing paradigms to enable features like Sentiment Analytics.

E. Utility Layer

Last but not the least cometh the utilities which are normally not considered as one of the functional parts of the systems, but plays a critical role in overall operations of any architecture implementation. Out of the many parameters, the most significant, which are worth addressing are security and configuration.

The fact that ChatBot solution is being exposed to a multitude of systems, channels and platforms, itself makes it highly vulnerable, and makes it mandatory for us to monitor and mitigate all the risks at all the touchpoints, whether it is for ingestion or pushing data out. Needless, to say, the various security components to be implemented should be capable to address the areas of usability, storage, network, authorization and exception handling.

Once all the functionalities have been implemented, tested and deployed for one customer, channel or platform, if we have to spend more or less the same amount of time and effort again for another customer, platform or channel, then the system is considered as not configurable. The configuration component is the one which satisfies the scalability and repeatability characteristic of the system. Thus it is critical for the success of the system to design and implement a configurable structure to enable plug-n-play of each and every feature and functionality of the system.

F. External services

Though the list and choice of external services depends on the domain of ChatBot implementation, still a complete ChatBot solution depends on some key external services in the likes of

- Contact/Support Centers/Systems, which are used by customer response staff to address the customer queries
- Social Media, which may provide contextual information
- Reporting and Analytics systems, which are used for offline data collection and analytics
- CRM systems, which are the legacy components having profile and organization specific information

IV. Architecture Implementations

There are so many different reasons people can use bots for and similarly there are equally that many types, bots can be categorized into. But for the sake of this research, let's restrict our discussion for the three main types of bots 1) a personal assistant, 2) a customer service bot and 3) a functional bot, and understand how the proposed standardized architecture can be implemented specifically for these three different yet similar ChatBot solutions.

A. ChatBot As A Personal Assistant

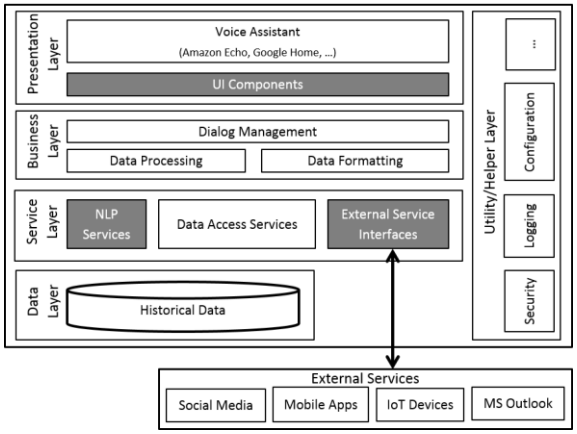

Fig. 3. Architecture – Personal Assistant Bot

This type of bots are designed to carry out conversations with a human. One of the main challenge in this type of bots is NLU, for which we have to be very careful about the choice of AI/NLP service, to avoid ending up into something like Tay. Tay was an AI ChatBot from Microsoft, which was attacked by so called hackers and broken, soon after it was launched. Another thing to be taken care of for these bots is the integration with external systems, as it is expected to perform lot of jobs and activities for or on behalf of the owner. An important aspect of a personal assistant ChatBot is the channel, which is normally restricted to very few, if not one or two.

Though, it might be required to customize and configure several components of the proposed architecture, following are the top three specific considerations and implementations expected for a ChatBot solution as a personal assistant. Please see Fig. 3 for representation of the specific implementation of a ChatBot solution architecture to work as a personal assistant.

1) ***UI Components:*** A personal assistant ChatBot is normally used by a specific person or a group of persons at home or at office. In most cases, it would be accessed using only one channel, like Google Home, Google Allo, Amazon Echo or the likes of it. So for this kind of bot, it would not be required to implement integrations with multiple channels or platforms, but focus specifically on the one channel of interest. And so, the concentration would be to implement the UI components, such that the user can indulge in a good conversation with the bots providing proper requests and responses.

2) ***NLP Services:*** It is normal to expect that personal assistant bot is able to understand the native languages and also its slangs, used by a person or a group of people. It should be able to recognise the terminologies and the context of the environment, in which it is operating. This calls for an NLP engine, which has a very efficient machine learning capability, to be able to respond to each and everything being asked for, to indulge in a successful conversation at the end. This implicitly requires the possibility of training the NLP engine manually when required and also capability of automatic learning based on the historical conversation.

3) ***External Service Interfaces:*** The third important functionality which differentiates a personal assistant bot from other bots, is its capability to be a super-bot and helping the user get everything done. Bots in this category normally act as agents on behalf of humans, and interact with multitude of external systems to accomplish specific transactions. For all such transactions, the proposed standardized architecture recommends to have specific adaptors and plugins to communicate seamlessly with each of the interfaces of external systems. Some typical examples of tasks include,

- Communication with IoT devices like TV, Refrigerator etc.
- Invoking other apps on the device, like Music, Video etc.
- Integrating with applications like Outlook Calendar, AccuWeather, etc.
- Communicating with ecommerce applications like Amazon etc.

B. ChatBot For Customer Service

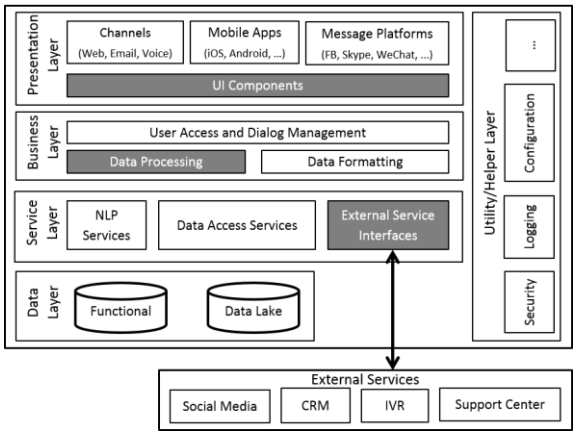

Fig. 4. Architecture – Customer Service Bot

It is a well-known fact that marketers are using various forms of communication to keep their customers engaged, as more engagement with means more business. Those companies that engage with customers on social media have shown higher sales record than before.

A ChatBot is a technological advancement and over the years it is expected to become the digital faces of all brands. ChatBots are expected to give the user an interactive experience, make customers feel they are working with someone to help resolve their issue. If done right, bots can help customers find what they are looking for and make them more likely to return. And this is exactly why a proper design and implementation of a ChatBot solution for customer service is critical for the success of the business.

Again, it is evident in this case also, that we need to customize and configure several components of the proposed architecture, but following are the top three specific considerations and implementations recommended for a ChatBot solution to work as a customer service agent. Please see Fig. 4 for representation of the specific implementation of this ChatBot solution architecture.

1) ***UI Components:*** One of the most critical objectives of any business is generating leads and retaining already existing clients. From every analysts' reports, it is clear that "Messaging is the #1 customer service channel preferred by consumers". Rather than directing customers to download an app or visit our website, we can initiate support and address their problems immediately with a ChatBot. To make this possible, we need to be where our customers are at all times, which means, we need to be omnipresent and available 24/7. Designing for conversational interfaces is a paradigm shift in thinking about interaction. ChatBots have less signifiers and affordances than websites and apps – which means designers have to work harder to deliver clarity to the user. Therefore, to increase reusability of components for interacting with multiple channels and platforms, we should identify and implement common user interaction patterns and components to reuse in multiple user interactions.

2) ***Data Processing:*** ChatBots shouldn't be the only foundation of our messaging experience. Instead, we can seamlessly mix human and bot interaction on our own branded experience. Performing a sentiment analysis on the data collected by all conversations can help businesses understand the feelings during entire lifecycle, as it forms a new source of big data, which businesses can take advantage of, in order to provide competitive and innovative features. One of the most popular, most wanted functionality is providing responses to FAQs, which normally takes a lot of time and effort for consumer to search through on the business's websites and find a suitable answer. All in all, a customer service ChatBot solution must process data from multiple sources and respond to the user with the most appropriate format and most relevant data. So while doing the design and implementation of this particular set of components, we should identify common data processing patterns and implement them as separate data processing components to reuse in multiple data processing scenario requirements.

3) ***External Service Interfaces:*** Businesses must ensure consistency in chat responses and most importantly, ensure a positive experience during a transaction. If the ChatBot solution can't help the customer, the program should be able to switch over to a human representative who can continue and complete the request. In that case, ChatBot solutions must enable access to the full context of the conversation with chat dialogs, emails, and CRM records to the live agent, so that they can serve the customer without asking again, what they are expected to already know. Businesses also need to remember and refer to personal information in future conversations to further customize a user's experiences.

Now to enable all these services, a ChatBot solution needs to integrate with many third party systems, like Social Media, CRM, IVR, Contact Support Centre Systems, Business Intelligence platforms and dashboards, etc. For all this to happen properly, the proposed standardized architecture recommends to have standard and reusable adaptors and plugins to communicate seamlessly with each of the interfaces of external systems, to transfer data both real time and in batch mode.

C. ChatBot for Performing a Function

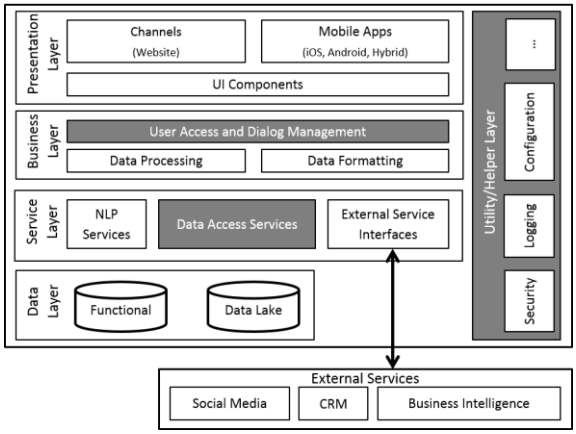

Fig. 5. Architecture – Functional Bot

"ChatBots could help save business costs by more than $8 billion per year by 2022", according to a new research which has anticipated a surge in automated customer service programs using artificial intelligence (AI). A functional ChatBot is one of the first ChatBot solution a business looks at, when it wants to experiment with this new disruptive technology. All big companies like Google, Facebook, Amazon, Apple, etc., are building bot-like services. This may seem kind of discouraging for many businesses, who want to build a bot for their business, as they might think, how can their little bot compete with Siri or Google Now? In reality, our bot doesn't have to compete with them, because, all these big companies are focusing on the "generalist" aspect of bots and bot platforms and what we are going to build is "specialist" bots. In fact, Bots that can do one thing well are more helpful that the bots that do many things poorly.

Following are the top three considerations and implementations expected for a Functional ChatBot solution, and Fig. 5 represents the same.

1) ***User Access and Dialog Management:*** We know that, if we want to be a leader in our business, we need to be an early adopter. ChatBot is expected to become the digital face of business brands and will become a signature feature to engage with customers. The interaction leaves users with an entertaining experience, a better understanding of the brand, and a positive emotional feeling—takeaways rarely achieved with traditional ads. All these is much more efficient and fruitful, if we implement a smooth, user friendly and easy to access "User Interface" like - remember and refer to personal information in future conversations and personalize a conversation to the individual. And that is possible only if we implement a robust single-sign-on (SSO) feature, working with numerous authentication mechanisms available along with an extensive storage of conversations with efficient analytics and access of data.

2) ***Data Access Services:*** Consider an example of an Insurance Bot, which can assist the prospects to browse through different policy options and suggest suitable policy for them based on their previous purchases, risk profile and coverage needs. They can also be used to help on-boarding customers, file claims on behalf of customers, and assist agents in addressing customer requests. Similarly, an AI powered recruiting ChatBot will be able to professionally answer any question about our company culture, benefits, or policies. This ChatBot can also intelligently gather information about qualifications, extracurricular, and certifications. Recruiting ChatBots will save us time, and let us focus on activities that create bigger business impact. By these examples, it becomes evident, that a ChatBot solution for a particular function must be well integrated and should be able to access all or multiple systems without breaking anything. They should be able find products and information, check their status and availability, take orders or booking, manage confirmation and payments and organize logistics and deliveries. That means, the whole success of failure depends on how well is the design and implementation of components for data access.

3) ***Security Management:*** ChatBots are deployed across many platforms and may have access to many internal systems, each of which have their own internal security requirements and considerations. We have to combine these built-in security measures with basic user security precautions, to provide both strong security and ease of accessibility. ChatBots also can be secured using same security strategies used for mobile technologies, like user authentication (Timeouts, Two-factor and Biometric), end-to-end encryption and self-destructing messages. Until public channels begin offering encryption services, organizations should be aware of the risks and mitigations, for the ChatBots they employ using those platforms. Before implementing a ChatBot, businesses must establish rules regarding the data the bot will gather and make these rules clear to the customers who will be using the bot. In addition, businesses must also consider where this data will reside, especially if the bot collects personal or sensitive information. All these are the main concerns, why a functional ChatBot solution should ensure secure storage and implement additional components regarding what gets stored, for how long, who can access and from where.

ChatBots can be quite destructive and end up causing cybersecurity nightmares for organizations that don't employ them properly. It is critical for organizations to not take a conservative, deliberate approach to ChatBot development and deployment. Strategically implemented and well-designed ChatBots can tell our brand story, re-engage audiences, facilitate commerce, and grow our business.

V. CONCLUSIONS

All businesses from all industries are experimenting with this new innovative channel. And why not? ChatBots have many benefits for businesses and consumers, alike. ChatBots are perfect for - generating leads, retaining already existing clients, guiding consumers to the checkout, providing a better user experience, integrating artificial intelligence and business and establishing quality customer service on social media platforms.

ChatBots are not only for customer service, but can be used for everything else, like marketing, sales, and also for internal communication like helping staff to provide information on policies. Gone are those days, when ChatBots were being used only from websites.

According to many latest reports, mobile apps are not delivering anymore, the level of adoption and customer engagement that brands and companies expect. There is huge cost for maintenance in addition to the marketing costs to drive the app downloads. ChatBots are the cheapest and fastest way of providing an engaging experience to users. Also, platforms like Facebook Messenger provide the necessary infrastructure for creating bots and businesses require very minimal maintenance.

In this paper, we have proposed a standardized architecture for a ChatBot Solution and also identified several critical components required for its effective implementation. These components are not exhaustive but definitely impact the performance of the system and user experience. Also many recommendations have been made wherever necessary. Applying all these techniques and implementing a compliant architecture would reap invaluable benefits and will ensure

- Superior experience to consumers
- Enhanced multi-channel capabilities
- Integrated services and delivery
- Differentiation in ChatBot space
- Advanced positioning of our organization in the field of innovation and technology

We should not build a ChatBot just for the sake of it or to be at the 'forefront of innovation', which might be a big mistake. ChatBots need to be properly understood and we have to really nail down the purpose of the bot and whether or not it will actually add value to our customers. We also have to realize, if it will really help them answer their queries, will it save them time and most importantly, will it be better than the current solutions out there? Without a proper design and implementation approach to this new technology, businesses will only end up wasting money and frustrating their consumers. That's why it's very important for businesses to understand the complexities and be prepared for the challenges.

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