FAST PROTOTYPING OF WEB BASED COLLABORATIVE PLATFORM FOR HELICOPTER PILOTS

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ABSTRACT

The current airspace structure is designed to prioritize air traffic services for flights taking place in controlled airspace, where ATC provides flight and alert information. However, flights performed outside the control areas receive no information from the ATC, especially if the flight occurs in class G airspace. São Paulo, for example, earned the title of metropolis of helicopters, surpassing New York with the number of aircrafts registered, the lack of important information, especially for helicopter pilots has been looking for alternatives to increase situational awareness and access all the information needed to make the flight not only efficient but mainly safe. In this work we propose a comprehensive process for fast prototyping of web based collaborative platform making extensive use of a secure messaging platform and single page application frameworks to achieve modularity and reuse in the construction of full fledge applications with flexible business rules.

Keywords: Fast Prototyping, VTOL, IoT, Ontology, Situational Awareness.

RESUMO

O formato da estrutura atual do espaço aéreo brasileiro foi pensado para priorizar serviços de tráfico aéreo para voos de aviões em espaço aéreo controlado, onde o controle de tráfico provê informação de voo e alertas. No entanto, voos que não são executados dentro de áreas controladas não recebem informações do ATC, especialmente voos que acontecem em espaços de classe G. São Paulo ganhou o título de metrópole dos helicópteros, ultrapassando Nova Iorque em números de aeronaves registradas. A falta de informação para pilotos de helicópteros fez com que estes procurassem fontes alternativas de informações essenciais para performarem suas tarefas em segurança, procurando consciência situacional. Neste artigo é apresentado uma ferramenta desenvolvida usando a metodologia de prototipação rápida para atender e concentrar informações necessárias para gerar consciência situacional para aqueles pilotos.

Palavras-chave: Prototipação rápida, VTOL, IoT, Ontologia, Consciência Situacional.

1. INTRODUCTION

With the increasing flow of helicopters in the proximity of Congonhas airport, the Department of Airspace Control (DECEA) implemented the Helicopter Control to reduce the risk of traffic conflict between IFR (Instrument Flight Rules) aircraft operating in the airport and the helicopters near the landing approach ramps at the airport's runway 17 (El País, 2016).

Several types of non-embedded applications have been identified for all kinds of supplementary information for navigation (ex.: eWAC Sul, Google Earth), weather (ex.: Camerite, RedMET), aeronautical information (ex.: FPL BR, AISWEB) and even for fuel calculation. For message exchange, social networking was the only resource found for sharing useful information for flight. Concentrating information for pilots is important to enhance the situational awareness and diminish time that they are out of focus searching for another application for a different information, decreasing the chances of an accident.

Building a prototype of a collaborative platform that covers most of their resources is a viable, value-added solution by optimizing, within a single platform, relevant data to increase situational awareness of the users of this system and allow the pilot to have more information to assist him during the flight, not interfering with the equipment on board the aircraft. In addition, one of the expected benefits of implementing this prototype is to minimize the information gap considered essential for helicopter operation whether in a controlled area or not. The use of this prototype during flight does not exempt the pilot in command from following the air traffic rules established by the competent authority and does not replace the mandatory see and avoid VFR flights.

Greater assertiveness in system requirements definition and gathering using navigable and/or functional prototypes is an unquestionable fact. In the work of Schön et al., 2017, an attempt is made to define the most used artifacts in Agile Requirements Engineering, 27 papers were analyzed, and two artifacts stood out, the use of User Story was identified in 56% of the papers and Prototype, in 41%. Prototype gains more prominence with the categorization made by the studies in different types of fidelity (low, mid and high fidelity) and the use terms as prototypes, mock-ups and wireframes.

For prototype implementation, tools and frameworks were selected and integrated in the solution and architectural styles such as the use of micro services and single page applications were explored, forcing data partitioning by domain, ensuring scalability, distribution and platform independence. To ensure a precise domain and fast creation of resources for manipulating data and information from servers, Atech has implemented a way of consuming an Ontology, which is a modeling of a knowledge domain with its entities semantically connected, and automating the creation of a database and workflows to enable orchestration among different micro services servers. In the specific case of componentization and configuration item management, the Building Blocks concept already applied to systems developed by Atech was used and improved following the processes described in Souza et al., 2016.

The process presented in this article will cover the construction of visual components and the organization of the services used, but will keep the research of the system's interface aside given that this paper will not focus on the construction and creation process of UX. This article also discusses Atech's gradual development of the perception about the product delivered to the final user and the expected outcomes from this development style. This article also involves a way of determining a domain in a very early stage of development by creating an ontology and automating more than half of the creation of servers and interoperability tools among them.

In this article, methodology of how the platform was developed will be explained. Next the results will be shown and followed by comments, conclusions and future work to enhance the prototype.

2. METHODOLOGY

Vertical Take-Off and Landing (VTOL) situational awareness is built on a shared common view of the aircraft in urban airspace, enabling pilots to collaborate in providing flight and weather information for greater safety and accuracy. Using GPS (Global Positioning System) of mobile devices, the helicopter's location is shared with the entire network of devices on the collaborative platform and each pilot can be aware of the location of other plots in real time. Within this scenario, application-based information sharing offers a new option to assist plots in the planning, flight, landing and takeoff phases.

The collaborative platform represents how devices, people and systems collaborate to achieve their goals. It consists of a connectivity solution between devices people and systems that promotes autonomous and collaborative actions of these agents in an essentially distributed ecosystem.

In order to accomplish this ambitious goal a pragmatic approach was planned and executed. The process definition should be complete and include all the supporting tools.

Some supporting processes were already defined and well established in the development and production environment. The main supporting process is described in Souza et. al, 2016. The foundation concept and systematic of the building block is the reuse of coded knowledge[] Other processes were defined inside the scope of this work, such as the co-creation process and prototype construction, but only the construction phase will be approached in this article.

From the tools and framework perspective, explorations were carried out in a small group of strict controlled projects that included production, proof of concept, investment and prospective projects.

Three phases were defined as shown in Dias et al. (2018) and for this solution, in the development phase will be presented the applicability of studies with ontologies in the creation of business domains and the use of a secure messaging platform for communication.

Data communication and availability is made through the secure messaging platform created by Atech LABs team, which uses the Extensible Messaging and Presence Protocol (XMPP), for XML text message exchange and a peer-to-peer encryption layer, ensuring security and integrity in the conversation between the parties.

In Figure 1 the final architecture of the system with the mobile environment and server infrastructure is presented. In the implementation of the IoT platform, various devices connect to the infrastructure located on a cloud machine and from there communicate with server nodes to pass on information. Within this node, a workflow, as described in Dias et al. (2018), orchestrates requests depending on the type of information exchanged. It is widespread for services such as database access, event history writing and information sharing through a common communication layer.

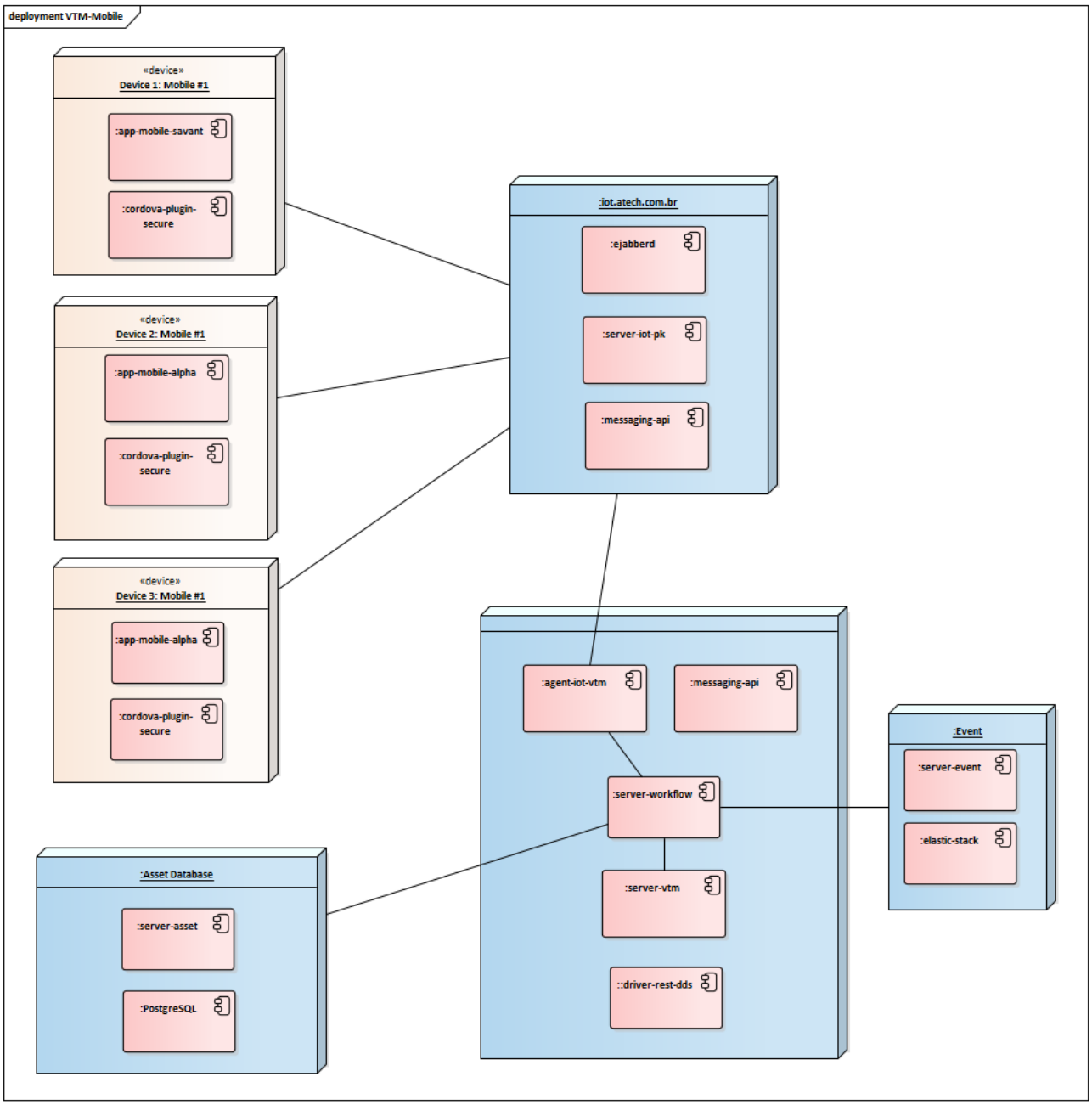


Figure 1: IoT platform architecture.

3. RESULTS

To achieve a generic process for development of prototypes of any domain, it is necessary to create a database as generic as for the addition of data of any type (Dias et al., 2018). The structure created consists of four relational tables, with one pair related to the metadata and its representations stored as Asset and the other pair related to the existing associations between them and its types. The metadata has base attributes such as id, name, description, the creation date and who created it. It is also possible to create any kind of extra data like the type or field elevation of an Airport or the length and width of a Runway.

The associations between Assets differ from the kind created by associations in conventional SQL databases. There is one table for the types of associations in the system and one that holds the associations themselves. It is possible to have relationships one-to-one or one-to-many. A model based on subject, predicate and object implements the meaning of all associations that are stored.

In this domain the database was built with the use of ontology that explicitly specifies a conceptualization (Persson et al., 2017). The

advantages of using ontologies is to assure that the subject-predicate-object concept will not be violated, since ontologies are built in such a form, it can store beyond data, it stores knowledge. The mechanism used by Atech not only ensures the storage of knowledge but also guarantees that interoperability to exchange such knowledge among servers involved in the system, creating along with the database, a series of workflow archives for basic manipulation tasks. These workflows will be used by Conductor. Having the database built, a server with micro services developed in Java allows access to the Assets by the basic methods of inserting, updating and deleting, and processing of data from user inputs by the mobile application. The use of Dropwizard as a framework for developing RESTful web services helps the application remain lean and focused, reducing both time-to-market and maintenance (Coda, 2018).

To handle all requests and reduce coupling between services, an orchestrator helps manage and coordinate tasks, centralizing, tracking and automating the workflows' execution. Conductor, an open source orchestrator created by Netflix, allows you to create complex processes or business flows from a JSON structure.

A workflow defines a series of tasks that need to be executed, its definition are versioned providing flexibility in managing upgrades and migration (Baraiya et al., 2018).

The orchestrator was used for the services of the mobile prototype application called ALPHA.

The prototype was built with hybrid development framework Cordova, an open source mobile development framework that allows the use of web technologies such as HTML, CSS and JavaScript for cross-platform development (Cordova, 2019), for the speed and ease in creating the application and already be compatible with Android and iOS operational systems. Using plugins, the app can access native components of the phone or use non-platform features. To use the implementation of the secure messaging, a plugin was created, enabling the creation and verification of pilots and the exchange and receipt of messages with de centralizer or any node in the platform.

The application send message to a centralizer called Agent, which process and/or passes the information to the orchestrator. In the system presented, the Agent is responsible for registering the pilot in the database, reviewing the location of the heliports present in the pilot's map view, provided by the airspace information server (Koroishi et al., 2017), saving the flight plans created and to distribute the location of all aircraft that are willing to share it.

Users positions are archived in a historical database and can be reviewed by the pilot or used for analysis if suspicious activity is occurring. As a collaborative platform, all users should be able to share their mobile phone's GPS location and then benefit from the viewing of other helicopters in the application.

The historical base created with the ElasticSearch database, which allows you to save data as documents and using the entire ElasticStack, it is possible to show the history in a map and make complex searches related to the area and date of an event, generating reports for the pilot himself or some supervisory entity.

For the approval of the ALPHA prototype (Aplicativo de Logística Para Helicópteros Atech), the interface is designed to be simple and fast for the pilot to use without losing any important information at the time of flight. The use of the visual framework called Ionic with Cordova enables rapid visualization of interfaces, and can change the color scheme and positioning of components and reuse common components such as registration screens, login and map visualization. Ionic allows you to create native interface for applications, leaving them within the guidelines described by each operating system, making the user feel no difference in use. In Figure 2 shows the initial map view of the pilot.



Figure 2: Initial visualization of ALPHA.

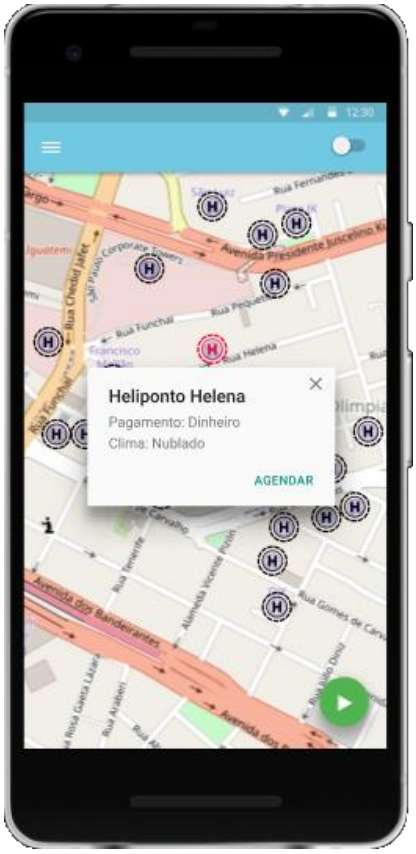


Figure 3: Scheduling a heliport in ALPHA.

In Figure 3, the sequence for scheduling a landing or takeoff time on a heliport is shown. The pilot chooses the heliport and checks the information and the building's status and weather on the spot, and then a schedule for takeoff or landing can be made.

Position sharing was designed in a simple way, a quick-triggering feature to avoid damaging pilots' flight time. Before the pilot has the whole view, the application asks the consent for use the app during flight. It is necessary that the pilot always pay attention to their surroundings. The consent alert is presented in Figure 4.

After accepting the term, when sharing is enabled, the pilot in question gains visibility from nearby helicopters while flying. As you approach the destination, a popup appears for the pilot showing location information as shown in Figure 5.



Figure 4: Term of responsibility.

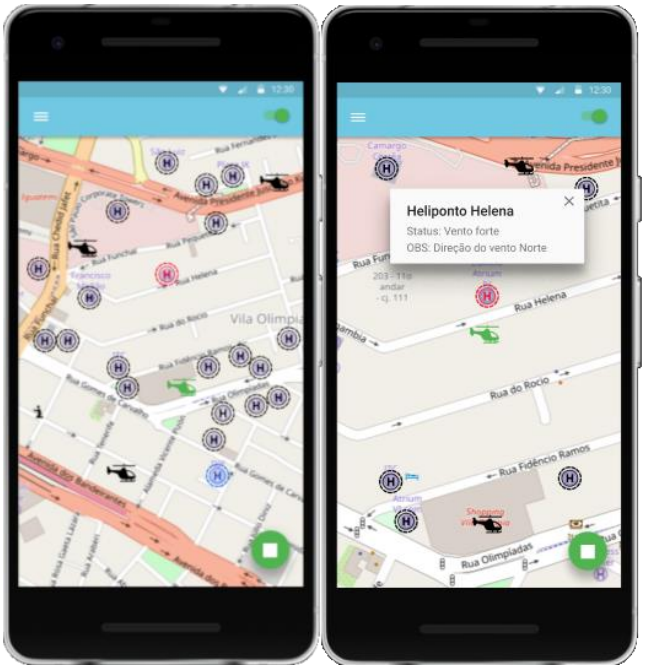


Figure 5: Flight of a helicopter with position sharing enabled.

As mentioned earlier, DECEA created in 2004, the area surrounding the runway 17 of Congonhas airport, called HeliControl, has a capacity for six simultaneous helicopter flights, according to the frequency of communication with control organization, and is an area that covers regions of the city of Sao Paulo that have a high flow of aircrafts (El País, 2016). To enter this controlled airspace, pilots need authorization. As the communication platform is carried out via VHF radio, contact if often impaired duo to frequency congestion. When this happens, both controllers and pilots need to change their schedules causing delays. The area can be visualized on the map and in Figure 6 is represented with maximum capacity reached.



Figure 6: Restriction area in runway 17 of Congonhas airport.

4. COMMENTS AND CONCLUSIONS

The platform aims to share information among users, increasing situational awareness for safer VTOL flights.

Flight restrictions and aircraft capacity in certain areas will be updated. Since its creation in 2014, the area surrounding the runway of Congonhas airport has undergone several capacity changes, ranging from 10 to 6 simultaneous helicopters, but has never undergone any overhaul. With the evolution of aircraft technology, navigation procedures and VTM system services for submitting flight plans

to control organization in an automated manner would enable a review of the Helicontrol area to increase helicopter flight capacity.

Features such as weather information (aeronautical and shared), aeronautical data, better heliport information and navigation data will be implemented. A module is planned in which heliports administrators can provide certain information about local weather conditions, point status, schedule management, usage pricing and integration with microclimate information and NOTAM (Notice to Airmen). When a certain level of maturity is reached, some performance and interface tests will be performed to improve functionality.

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