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Integrated Electronic Logbook

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Author Note: All cadet authors are members of the Department of Systems Engineering at the United States Military Academy. They will commission in May of 2018 and look forward to a career as officers in the United States Army. Each cadet has a solid background in the systems engineering field and was chosen to assist the Project Management Unmanned Aerial Systems (PMUAS) team at Redstone Arsenal in creating an Integrated Electronic Logbook (IELB) for the Shadow drone platform.

Abstract: The current Universal Ground Control Station (UGCS) for US Army Shadow and Gray Eagle drones require manual input of all flight records into the flight record system. The purpose of creating an IELB is to create a more efficient system to accurately record flight data for Unmanned Aerial Systems (UAS). In utilizing a combined systems approach, this capstone project develops a concept of operations (CONOPs) for PMUAS at Redstone Arsenal to guide the development of an IELB for the Shadow drone platform. The intent of this paper is to provide the background information necessary in generating a CONOPs for the IELB.

Keywords: Project Management Unmanned Aerial Systems (PMUAS), Universal Ground Control Station (UGCS), Integrated Electronic Logbook (IELB), Unmanned Aerial Systems (UAS), Concept of Operations (CONOPs)

1. Centralized Aviation Flight Record System

The Centralized Aviation Flight Record System (CAFRS) is a universal flight record system that is used for all aircraft across the Army. This system is internet accessible to provide pilots with access to their flight information regardless of their duty station. The purpose of this system is to make flight information both secure and easily accessible for senior-level officers so that they can most effectively manage their resources and personnel. It is also used to create risk assessments. CAFRS tracks a variety of different flight records that are used to track the progression of various different pilots. The most current version of this system is version 4.0. The system in place before CAFRS was the three legacy system, which was composed the Microsoft Disk Operating System, Aviation Center Flight Records System, and the Unit Level Logistics-Aviation flight operations module (Pomranky-Hartnett et al., 2015).

1.1 CAFRS Background

CAFRS has three components. It is used to track aircrew flight records and training records, unmanned aircraft system (UAS) operators' hours, and air traffic control training records. We are most interested in the UAS operators' hours, but the database is structured the same for all three types of personnel. It is also a database that can be installed on any Windows operating system (Pomranky-Hartnett et al., 2015). During deployments, CAFRS is used at the battalion and company levels to store flight records in local databases. This information is then compiled and shared with the Central Database Server located at Redstone Arsenal, Alabama.

CAFRS is comprised of three different tiers (Pomranky-Hartnett et al., 2015). The uppermost tier is split into the primary Central Database Enterprise Server and the secondary Central Database Enterprise Server. The subsequent tier is composed of CDCPs (CAFRS Data Collection Points) which are emplaced at the battalion level. The purpose of the CDCPs is to upload to the Central Database Server and keep the flight information current. The bottommost tier of CAFRS are the client machines, which is defined as, "…any government computer that has the CAFRS client application installed," (Pomranky-Hartnett et al., 2015).

Inside of CAFRS, there are two identities (Pomranky-Hartnett et al., 2015). A user is someone that has been given credentials to access the flight data. Users tend to not have any flight records themselves. They are solely in charge of managing the flight records. The other identity is the aviator themselves, which can be the either a rated or non-rated crew member or a UAS operator.

1.2 Current System

Studies have identified some usability issues with some of the design characteristics of CAFRS client machines. Each individual was given a train-up period and then given tasks to perform within the CAFRS client machines. According to the study conducted by the *Army Research Laboratory*, the test subjects filling the task as the aviator found no problems (Pomranky-Hartnett et al., 2015). However, the user group found that some of the steps were not logical and that some of the tasks required an excessive number of steps. This prevented some from being able to quickly perform the task. However, the vast majority of test subjects reported that the menu screens were easily understandable and that the error messages were equally comprehensible and accommodating.

In addition to Army records, professors at the United States Military Academy (USMA) with flight experience were interviewed as well. Both MAJ David Dunham and MAJ Robert Briggs were CH-47 pilots that both experienced company command time in their respective flight units. According to MAJ David Dunham, flight hours were manually uploaded to CAFRS computers (personal communication, January 10, 2018). In his experience, they experienced no issues with aviators inputting their flight hours because every aviator had an incentive to input the hours they had flown to achieve their flight progressions. Additionally, unlike UAS operators, there are only two pilots in each CH-47 and there is no change of pilots like in the Ground Control Station (GCS) of a UAS.

After the flight hours were logged in to the company CAFRS computers, a 15P military occupational specialty (MOS) on the battalion level updates the battalion CDCP by manually plugging into the company CAFRS computers once a month. MAJ Briggs had experiences very similar to this, but instead of a 15P MOS, his battalion had a designated CAFRS clerk. According to Kevin Luhmann, the Foreign Military Sales Program Integrator for Nonstandard UAS at Redstone Arsenal, there exists an automated link between the battalion CDCP and the CAFRS Central Database server once the battalion CDCP is turn on (personal communication, February 22, 2018). This synchronization can occur as frequently as once a day.

2. Modular Open System Architecture

According to R. N. Langlois, a professor of economics at the University of Connecticut, modularity is, “a general set of principles that help with managing complexity through breaking up a complex system into discrete pieces, which can then communicate with one another only through standardized interfaces” (2002). Therefore an increase in modularity decreases complexity of a problem by dividing the problem into smaller manageable portions. The challenge that comes with augmented modularity however is that important system details can be lost in the translation. In applying modularity to an open architecture system architecture, the complexity of modularity increases by making the different multifaceted aspects interchangeable and updateable. The optimal way to alleviate this complexity is through combining principles where possible without disrupting the whole system (Heydari et al., 2016). The benefit to incorporating modularity the structure of the IELB is that each component of the logbook can be updated separately as opposed to updating the whole system. Taking the time to separate the components of the IELB into independent working components would prove invaluable to engineers tasked to update the system in the future.

Another benefit to modularity comes with the increased variety of situations a system can react to (Heydari et al., 2016). By decentralizing the architecture of a system, more problem areas can be identified by increasing the number of stakeholders involved in the system. Diversifying stakeholders in an open environment inherently makes the system more robust. The more stakeholders in a system, the higher the probability that every angle of the problem will be looked at with an appropriate degree of focus. In the case of the IELB, this means that operators, users, and PMUAS should all be contacted for their input because they all have different values.

3. Future Airborne Capability Environment (FACE)

The FACE Enterprise is made up of stakeholders that represent government (Department of Defense), industry, and academia, in order to reach a common goal of proposing, developing, and implementing FACE conformant software onto DoD aircraft and other environments. In order to implement different ideas for FACE, a group was created to further the achievement of business objectives through open standards and certification. This group is called the Open Group and is a global consortium that is neutral that gives no bias or favoritism to any one group in order to keep the standards across the field. The FACE Consortium is a Voluntary Consensus Standards Body comprised of US Government, Industry, and Academia representatives

(Seen in Figure 1).. The FACE Consortium vision is an enduring FACE Enterprise that promotes and utilizes evolutionary technologies and business practices to provide portable, reusable, and interoperable software across the aviation community, resulting in faster delivery of capabilities and lower implementation and lifecycle costs.

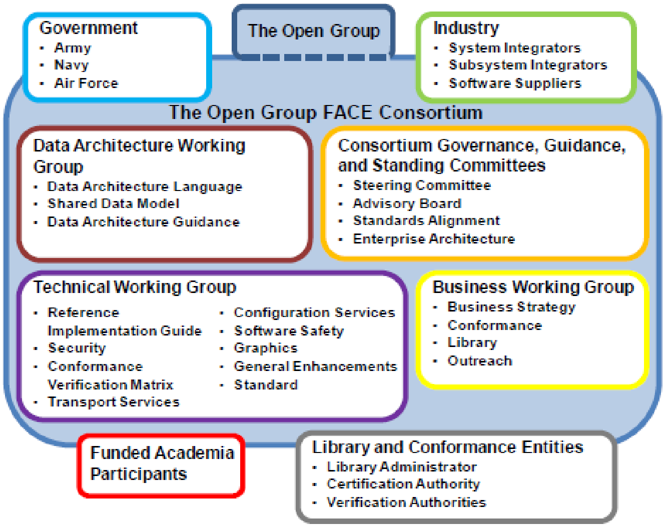

Figure 1. Open Group FACE Consortium

4. Operational View and Systems View Formats

4.1 Operational Viewpoints

Operational Viewpoints with regards to the Department of Defense Architecture Framework (DoDAF) describes the tasks and activities, operational elements, and resource flow exchanges required to conduct operations. Normally, operational models are materiel independent, but for the purposes of our capstone project, it will be necessary to document the way that technologies affect the old system and how those technologies could be streamlined to update the system. One important way that architectural modeling supports the definition of requirements is in terms of boundary definition. Boundary definition is a process that often requires a significant degree of stakeholder engagement; the described models provided by DoDAF provide ideal support for this interactive process. Operational models can be used to help answer questions such as “what is the functional scope of the capability or capabilities for which I am responsible?” or “what is the organizational span of influence of this capability or capabilities?” or “what information must be passed between capabilities?”

4.2 Systems Viewpoints

The Systems Viewpoint of the DoDAF describes the systems that interconnect DoD functions (both warfighting and business). The systems resources support the operational activities and facilitate the exchange of information throughout the entire operation. The Systems Viewpoint 1 is designed to help define systems concepts and options while helping with capability integration planning and management. The SV-1 will help define and describe a solution option with regards to the capabilities of certain components and their physical integration among multiple platforms and facilities. Figure 2 depicts a current proposed solution for how the I.E.L.B. works with the rest of the drone system. It shows the first UGCS with the information inputted by the operators within the first UGCS. It then depicts the packet of information being sent to the drone and held within the drone so that if/when the drone’s flight path takes it out of the UGCS boundary limits, the information from the first UGCS is retained. After linking with the second UGCS, the drone then receives the information from the I.E.L.B. at

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UGCS #2. The drone then has information from both UGCS #1 and UGCS #2 so that when it lands all information will be recorded into CAFRS.

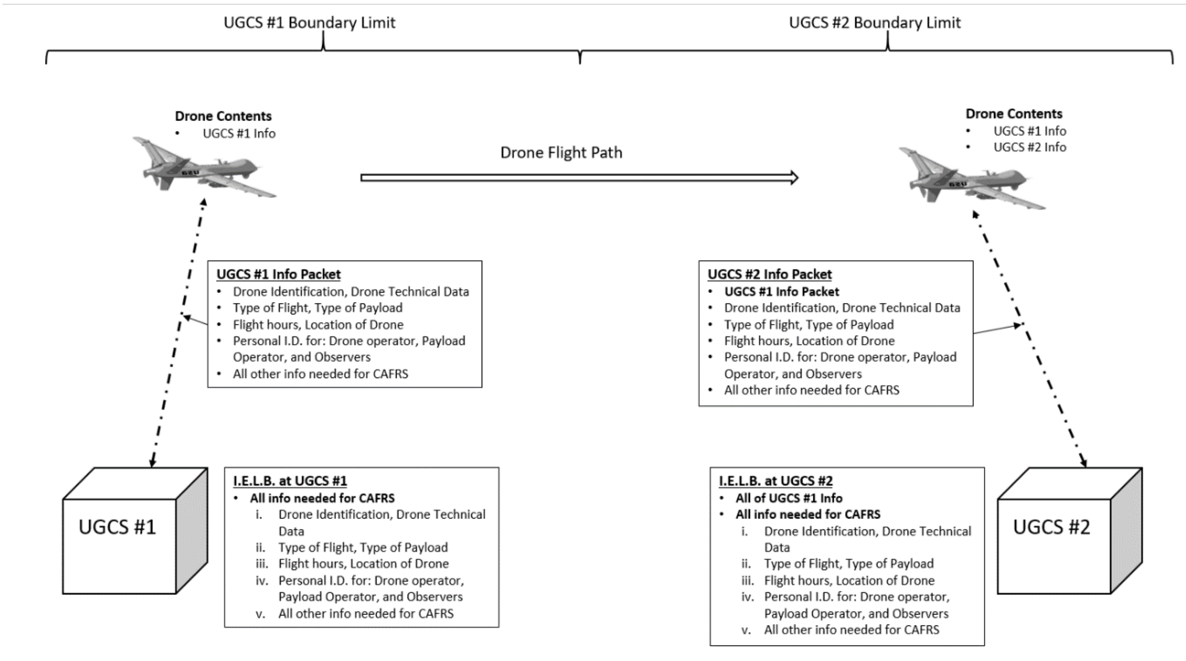

Figure 2. SV-1 of Proposed Solution

5. Unmanned Aerial Systems (UAS)

5.1 Unmanned Aerial System Background

The Unmanned Aircraft System (UAS) has rapidly become a necessity for military and civilian operations. UAS today play an increasing role in many public missions such as: border surveillance, wildlife surveys, military training, weather monitoring, and local law enforcement (Watts, 2012). Additionally, UAS's take the role of many dangerous missions, relieving human pilots from risky operations (Grupta, g., etc., 2012). Therefore, the importance of a UAS to operate smoothly during a mission is vital. The lives of U.S. soldiers rely on these aircraft systems, and the UAS must contain promising characteristics to ensure mission success. For example, some characteristics are long flight duration, improved mission safety, flight repeatability due to improving autopilots, and reduced operational costs when compared to manned aircraft (Grupta, g., etc., 2012). "Advantages of an unmanned platform, however, depend on many factors, such as aircraft, sensor types, mission objectives, and the current UAS regulatory requirements for operations of the particular platform" (Grupta, g., etc., 2012). Many of these factors depend on a variety of things. The operational environment, enemy, and type of mission are some of the things that have an effect on how the UAS is going to operate.

5.2 Unmanned Aircraft Control Segment (UCS)

An additional Part of the UAS system is the Unmanned Control Segment (UCS). There are many goals and objectives to consider while designing a control system. An unmanned control segment (UCS) is crucial for the design of the system. Additionally, the unmanned aircraft control system architecture builds a strong foundation by coming up with goals and objectives. Figure 3 establishes the goals and objectives of the UCS architecture design. The figure provides some of the main focuses a group should have while designing the UAS (Gregory, D., 2013).

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Business Goals	Architecture Supported Objectives	Warfighter Capability
Target affordability & control cost growth	Exercise IP rights to reuse components. Reduce obsolete technology and lifecycle support costs. Reduce T&E across portfolio.	Redirect savings to fund enhanced Warfighter capabilities.
Incentivize productivity & innovation in industry	Reward adoption of OA principles. Disclose designs to foster innovation and collaboration. Invigorate R&D. Reduce tech insertion cycle.	Availability of new applications/services. Accelerated fielding of applications/services to counter threats.
Promote real competition	Compete UCS applications/services. Remove obstacles to competition by disclosing designs.	Access to applications/services not previously released in UCS market.

Figure 3. Goals and Objectives

6. Conclusion

In order to assist the PMUAS team with creating an improved IELB, the most updated requirements of CAFRS and FACE had to be researched and analyzed. Once the requirements of these two standards were identified, an actual proposed mapping of the new system could be created. In addition to working in parallel with these standards, the most recent developments in modular open architecture was researched so that the IELB may be more easily updated in the future. Using this information, a systems viewpoint mapping was created to integrate all the requirements the current logbook satisfied as well as to introduce possible areas of enhancement. The systems viewpoint created will then be used by engineers at Redstone Arsenal to assess and apply the feasibility of this proposed solution.

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