Note

Procuring commercial-off-the-shelf software for Air Traffic Services systems in state-owned organizations: A client-centered case study in Spain

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A B S T R A C T

This paper reports preliminary findings of a client-centered exploratory study on how Commercial Off-The-Shelf (COTS) software influences the procurement of Air Traffic Services (ATS) systems in state-owned organizations. Our work carried out an initial qualitative study on the case of the Spanish Automated Air Traffic Control System (SACTA) in ENAIRE, the national Air Navigation Services Provider (ANSP). As a result, we present an tentative model of the case where a series of emerging ideas is identified. These ideas constitute a client-centered conceptual framework that may help state-owned organizations understand some phenomena associated to the evaluation and procurement of COTS-based ATS systems.

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1. Introduction

Air Traffic Services (ATS) systems constitute an essential support element of the Air Traffic Management (ATM) system. Such systems enable a safer and more efficient operation of air transit by integrating information from a variety of sources such as flight plans, Communications, Navigation and Surveillance (CNS) systems or aeronautical and meteorological information providers. In addition, modern ATS systems automate routine functions, thus contributing to a reduction of the operator workload. Hence the importance of acquiring proper ATS systems and optimizing its performance throughout its life-cycle.

Commercial Off-The-Shelf (COTS) software has proved to be one of the principal factors influencing decision making when it comes to the procurement of new Information and Communication Technology (ICT) systems or upgrades for legacy systems.

COTS software is commercial software that can be built into and integrated within other software projects. It has been widely studied in the general domain given the supposed benefits they offer to speed up the development process and reduce overhead costs. Some studies focused on proving the advantages of COTS software solutions over bespoke ones (Blanchette, 2005; Morisio et al., 2002). According to those studies, COTS solutions do not always reduce the investment of time and effort required to successfully complete the project, rather they change the way the project has to be handled. Greater focus has been put on the integration issues of COTS software such as detection and solution of interoperability problems (Wile et al., 2010; Couts and Gerdes, 2010).

COTS software is starting to become commonplace also in the field of safety-critical applications. Safety-critical systems are those systems whose failure could result in loss of life or significant damage to the environment. The need to establish specific guidelines to ensure the suitability of COTS software components for safety-critical applications was already identified by Kohl (1999) along with the shortage of empirical research in the field. Two main problems with the integration of COTS software components into large safety-critical systems were identified by Dawkins and Kelly (1997): a) potential systematic errors can be introduced by poor integrations of COTS software; and b) difficulties to meet the requirements of the safety case. The use of COTS software within safety-critical domains is supported by Wetherholt (2009), who

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concluded that some modifications in the software assurance and safety approaches need to be done in order to ensure the successful assurance of COTS-based products.

Aviation is a good example of a safety-critical environment where the research on COTS software is still very limited and focuses mainly on airborne systems and certification processes (Alford, 2001; Ferrell and Ferrell, 2001). Although COTS software could become an economical alternative to bespoke software for aviation systems, thorough planning is needed to reduce recertifications.

Research on COTS software for ground-based ATS systems is extremely scarce and tackles very specific applications such as the selection of operative systems (Pierce et al., 1999). The case study conducted by Kesseler (2008), which analyzed a COTS-based ATS system, could not corroborate the expected benefits of COTS software. This study also evidenced how the management style can dramatically influence the outcome of the project. Kesseler (2004) analyzed and compared several safety-critical software standards and guidelines, including the previous editions of the main standards widely used for the development of aeronautical airborne systems (DO-178/ED-12) (RTCA/EUROCAE, 2012a) and ground-based systems (DO-278/ED-109) (RTCA/EUROCAE, 2012b). Both standards consider the use of COTS-based systems. In Europe, Commission Regulation (EC) No 482/2008 lays down software safety assurance requirements to be met by Air Navigation Services Providers (ANSPs) through a Safety Management System (SMS) (European Commission, 2008). This regulation is based on the EUROCONTROL Safety Regulatory Requirement addressing software in ATM systems (ESARR 6) (EUROCONTROL, 2002). EC No 482/2008 leaves in National Supervisory Authorities' hands the decision to accept alternative means of compliance to support the safety case of COTS software integrations. Nevertheless, the European Aviation Safety Agency (EASA) continues to expand its responsibilities in the ATM field and new extensive regulatory material on ground-based ATM systems is underway (EASA, 2014). It is expected that the European Commission will soon draft new related implementing rules to amend or even replace EC No 482/2008. Subsequently, EASA should promulgate its own Acceptable Means of Compliance (AMC) and Guidance Material (GM) partially based on ED-153, the most commonly used AMC to EC No 482/2008 (EUROCAE, 2009).

Despite the evident relationship between the performance of the ATS system and economic development, the impact of COTS software on the procurement of ATS systems by state-owned Air Navigation Services Providers (ANSPs) is a topic that has not been studied in the literature yet. This paper aims to help fill the research gap in this area by introducing the results of our initial approach to the issue of COTS software for ATS systems in the Spanish Air Navigation Services Provider (ENAIRE).

2. Case approach

2.1. Case selection

State-owned ANSP raise a particular interest insofar as public money is directly or indirectly at stake. The Spanish Automated Air Traffic Control System (SACTA) was developed for ENAIRE in 1984. SACTA comprises a fully integrated network of ATS automation systems at Area Control Centers (ACCs) and Control Towers (TWRs) (civil and military), enabling seamless interoperability among them. A key factor contributing to the success of this bespoke system, developed from-scratch by the Spanish company Indra, is the fact that SACTA is in operation at every single Spanish ATS

facility, thereby avoiding the problems that arise when dealing with different ATS systems from different providers. The Automation Division of ENAIRE, which is based at the headquarters in Madrid, centralizes the software verification, validation and strategic management of SACTA across the entire Spanish territory, standardizing decisions and studies on potential integrations of COTS software.

Over the last few years, new regulatory scenarios and a recession economy have been putting state-owned ANSPs under pressure to reduce costs in order to confront new models of competition while maintaining or even improving safety levels at the same time. In Europe, one of the main aims of the Single European Sky (SES) initiative, promoted by the European Commission, is to prevent existing public ATS monopolies by facilitating the set-up of new free market models. The emergence of new institutional models for the provision of air navigation services (Button and McDougall, 2006) and the SES initiative have led to the liberalization of ATS in Spain (Gómez Comendador et al., 2012), and so to the emergence of new privately-owned ATS/CNS providers which may represent tough competition to ENAIRE. The new ANSP might decide to replace SACTA with different ATS systems following a COTS strategy in order to reduce costs.

The following criteria, borrowed from the work of Oates (2006), justify the relevance of a case study about the impact of COTS software on the procurement of SACTA in ENAIRE:

- *Generalization*: Despite the peculiarities of SACTA and the impossibility to generalize results due to the adopted research methodology, the insights of this research may be of interest for other governmental or state-owned ANSPs and ATS systems providers.
- *Opportunity*: There is presently a lack of well-grounded methodology to support decision makers during the evaluation of new COTS software in an ATS context.
- *Convenience*: Many professionals conveyed their interest to analyze the impact of COTS software on their daily activities with SACTA from a scientific point of view.
- *Novelty*: The integrated network-centric model of SACTA makes the case unique.

2.2. Methodological approach

The exploratory case study is the methodology that best serves the objectives of this research. Our work followed a flexible use of the Paradigm Model (Corbin and Strauss, 2014), a conceptual analytical tool in the context of the Grounded Theory, which was used to create a simplified model of the case out of the qualitative analysis. We carried out an initial inductive analysis inspired by Grounded Theory, yet identifying some initial ideas as starting point (Robson, 2002). We also followed an interpretivist paradigm since the focus of our research was put on the understanding of the social context of the case rather than on technical details. The insights obtained may help tackle initial approaches to similar cases, but the outcomes cannot be generalized.

We conducted this preliminary study focused on the point of view of the client, the Automation Division of ENAIRE. It is expected that this first approach can shed more light on the matter than approaches focused on other main actors involved such as the Air Traffic Controllers (ATCOs) (end user), Indra (ENAIRE's current ATS systems provider) and potential future COTS systems providers. The results obtained from this client-centered approach will constitute a solid basis for further research on the way to an integral approach