Chapter 2
Cognitive Aeronautical Communication System

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ABSTRACT
The paper explores the system and architecture requirements for cognitive driven reconfigurable hardware for an aeronautical platform, such as commercial aircraft or high altitude platforms. With advances in components and processing hardware, mobile platforms are ideal candidates to have configurable hardware that can morph itself, given the location and available wireless service. This paper proposes a system for an intelligent self-configurable software and hardware solution for an aeronautical system.

INTRODUCTION AND OVERVIEW
Wireless connectivity has come a long ways in providing reliable and bandwidth efficient data connectivity. Given the limited resource in multi-dimensional electro-space, i.e. time, frequency, space, polarization, modulation/orthogonal signalization; an increase in data rate can be achieved through multi-dimensional resource efficiency. To achieve higher spectral density (Wertz & Larson, 1999), higher signal energy over noise ($E_b/N_0$) is required (Signal Processing Design Line, n.d.) to support the different links.

In the past few decades, the increased time spent in the air by higher numbers of users (Bureau of Transportation Statistics, n.d.) is creating a demand for data in in-flight services (Lai, 1998). In addition, the aircraft can be used as a relay. Therefore, aircraft based Aeronautical Data Networks (ADN) for future wireless communication structure is increasingly being discussed. All programs lead by National Aeronautics and Space Administration (NASA), Federal Aviation Administration (FAA), European Union (EU) and EUROCONTROL are including the aeronautical platform as part of the network (NASA, 2009; Gilbert, Jin, Berger, & Henriksen, 2008; Newsky, n.d.). A key enabler would be a robust physical layer. From the networking point of view, there
are a couple of studies, where in-flight internet with both aeronautical ad-hoc networking and centralized manner strategies are discussed (Sakhaee & Jamalipour, 2006; Medina, Hoffman, Ayaz, & Rokitansky, 2009). The global movement of the aeronautical system can take advantage of emerging wireless services and standards. This paper explores the concept for a Cognitive Aeronautical Software Defined Radio (CASDR). The organization of this paper is as follows: the following section discusses the driving motivation for CASDR. The CASDR system requirements are then established. In addition, the problem statement for Doppler and its effects to the physical layer in aeronautical scenario are investigated. The proposed hardware system definition for aeronautical software defined radio is given. In the last section, conclusions and a roadmap for future studies are provided.

**MOTIVATION AND CHALLENGES**

The ever-changing geographical environment of an aircraft and an increasing availability of different wireless services makes one wonder, what if such services can be accessed in real time? This provided the motivation to develop a concept system and its hardware that would accommodate to the rapid changes, not just due to the aircraft location, but also to support the growth of services and industry evolution.

Figure 1 depicts the notional framework of opportunistic wireless data service that may be available for an aircraft in flight. At higher altitude the services may be more traditional and fixed, however on ground, the growing WiMAX and local area network services may be available to be accessed from the aircraft. The high-speed mobility of an aircraft adds additional challenges to the design of system physical layer, such as path loss and multi-Doppler spread (Medina et al., 2008; Erturk, Haque, & Arslan, 2010).

**REVIEW OF LITERATURE**

The desire for a universal and a reconfigurable terminal first appeared in the military area. The need for mobility and accessibility was the driv-
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