An Introduction to ChipRate

Abstract

I graduated from the University of Aberdeen with a degree in electronics and electrical engineering. As part of the finial year of my degree I completed an undergraduate thesis where I considered the concept of a multi static passive radar system capable of tracking commercial civil aircraft using transmitters of opportunity. I aim to use this journal as a means of exploring the ideas outlined in my thesis and expand upon them. Using this journal I will break down my thesis and re-examine the background, principals, motivations, benefits and applications of a multi static passive radar system.

Table of Contents

Acronyms

GPS	Global Positioning System
SESAR	Single European Sky ATM Research
RADAR	Radio Detection and Ranging

Introduction

As part of the finial year of my degree at the University of Aberdeen I completed an undergraduate thesis. In my thesis I considered the concept of a multi static passive radar system capable of tracking civil aircraft using transmitters of opportunity.

I aim to use this journal as a means of exploring the ideas outlined in my thesis and expanding upon them. Using this journal I will break down my thesis and re-examine the background, principals, motivations, benefits and applications of a multi static passive radar system.

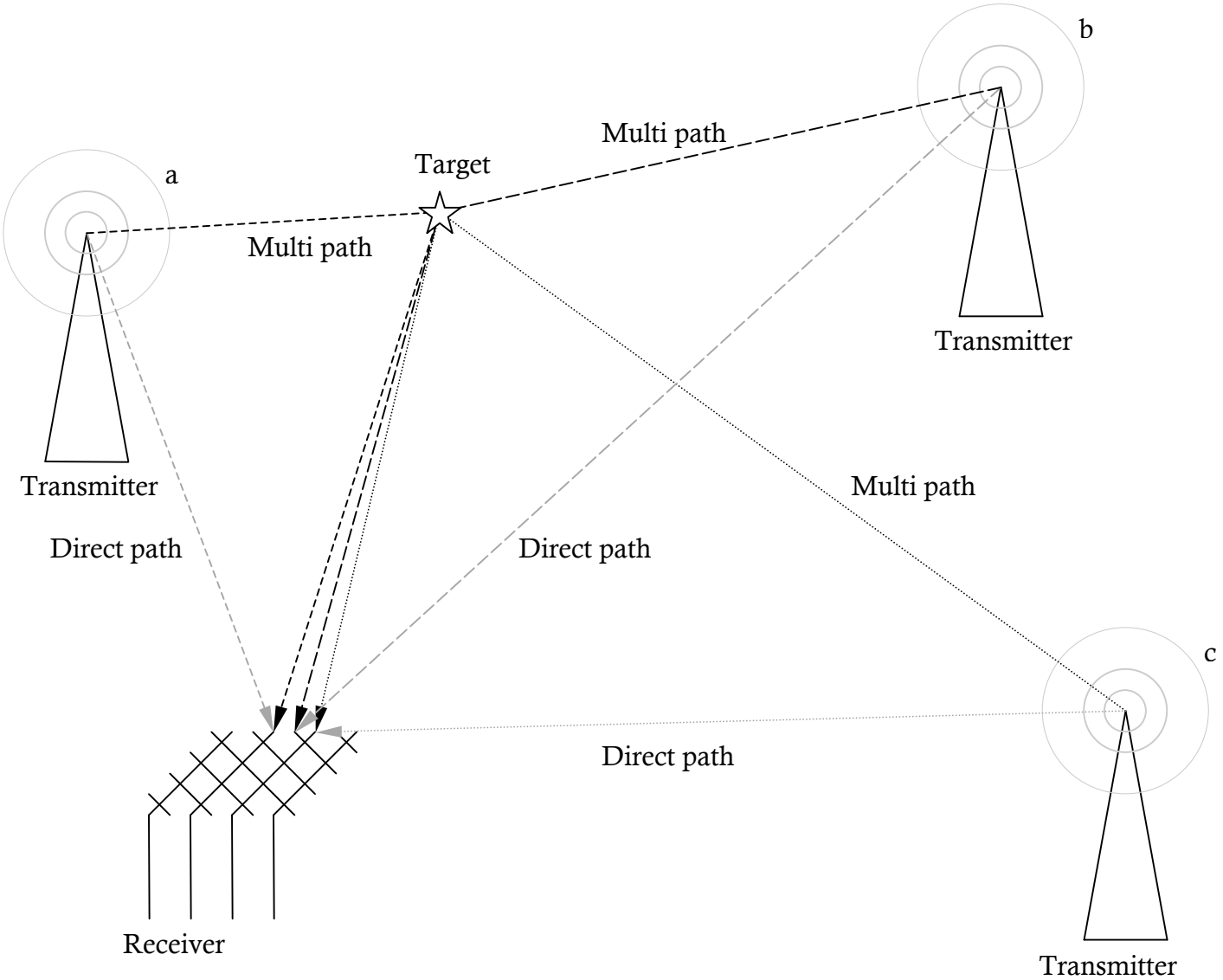

Figure 1

This entry will discuss the motivation behind a civil aviation application for a passive radar system.

Background

Civil aviation infrastructure is under immense stress. Passengers are demanding better quality of service, fewer delays, that there be lower prices and a guaranteed level of safety. Current civil aviation traffic management systems are based on technology that was developed in the 1950s and 1970s. These systems are currently reaching their maximum capacity amidst contending with accelerating passenger numbers, which in the UK are set to double from their 1998 high of 33.6 million passengers to a predicted 71 million passengers in 2020 (Department for Transport, 2004). This tremendous stress will take these systems to their limit. To scale and maintain the current systems to meet the predicted traffic in 2020 would cost between €14 and €18 billion per year (European Commission Directorate General for Energy and Transport, 2005). This is not sustainable.

The Single European Sky Industrial and Technological programme (SESAR) aims to ensure the safety and efficiency of air traffic Europe wide by developing new organisational methods as well as developing a new generation of air traffic management systems. The fulfilment of SERARs objectives will involve the reorganization and standardization of European airspace alongside the modernization of air traffic management systems.

The Galileo European satellite navigational system is the world's first that is open to all. When complete the system will consist of 30 satellites and ground stations that provide navigational and positioning information. The system's operation is technically identical to the American Global Positioning System. The American system is primarily a military system and offers no guarantee of precision or reliability for civilian users. The American system can also be switched off for all but the American military if there were any perceived threat. The European Galileo system will offer everybody everywhere guaranteed reliability. This allows the Galileo system to be used as a reliable source of navigation in many transport applications. One specific application (and one of the technical challenges detailed in the SERAR project) is the freeing of aircraft from the rigid trajectories between fixed points that

current systems impose. The benefits of freeing aircraft from fixed trajectories are gained through more direct flight routes, thereby saving time, reducing congestion, reducing noise, saving fuel and reducing carbon emissions. Areas where trajectories have been opened and new routes established will not be covered by current air traffic management radar. To maintain a high level of aviation safety, the monitoring of aircraft must contain systems redundancy i.e. a minimum of two systems monitoring any aircraft at one time. An efficient solution to this problem is a low cost multi-static radar system.

Multi-static radar has the potential to provide a wide area of coverage using only receivers of modest performance. This is achieved by exploiting cheap computing power. Powerful computer systems capable of the complex digital signal processing required in a multi-static system are available at a relatively low cost. This allows cost effective systems to be built to cover wide areas that may be used in areas where traditional mono-static active radar systems would not be cost effective. A multi-static system also contains inherent redundancy.

Motivations

A passive system could be a potential competitor to current mono-static systems in terms of cost. A passive radar system has inherent advantage over a traditional mono static system in that it uses signals of opportunity which are free and numerous. A mono static system has to transmit its own signal, which requires complex switching systems to allow it to both transmit and receive using the same antenna. The proposed passive system uses a bi-static geometric configuration, which does not require switching.

The proposed system has many potential applications and markets. Applications include.

- Opening up flight paths and expanding current capacity of current civil systems in Europe
- Providing low cost coverage for airports that would not be able to afford expensive mono static systems. This applies to small airports in the developed world but also larger airports in the developing world

- The system lends itself to security and military applications. A system could be easily being made portable. The proposed system also lends itself to military and security applications, as it is inherently difficult to jam and its use impossible to detect preventing the user from becoming a target.

New technology such as the Galileo European satellite navigational system could change the civil aviation industry and produce opportunities for a multi static passive radar system. The Galileo European satellite navigational system is the world's first that is open to all. One specific application (and one of the technical challenges detailed in the SESAR project) is the freeing of aircraft from the rigid trajectories between fixed points that current systems impose. Where there will be areas where the trajectories have been opened and new routes established there would be areas, which will not be covered by current air traffic management radar. To maintain a high level of aviation safety, the monitoring of aircraft must contain systems redundancy i.e. a minimum of two systems monitoring any aircraft at one time. Monitoring the positions of civil aircraft as a secondary system is an example of such an opportunity.

Contact Me

I would appreciate any feedback on my work, positive or negative. I would be especially interested to hear for people in industry or academia as I am currently looking for an opportunity in engineering. I am particularly interested in digital signal processing, FPGAs, algorithm design, MATLAB and system design. By far the easiest way to contact me is by e-mail andrew@chiprate.co.uk. For more up to date information please refer to www.chiprate.co.uk.